From the Indian Institute of Sugarcane Research, Lucknow.
With the Compliments of the Director.

ANNUAL REPORT

OF THE

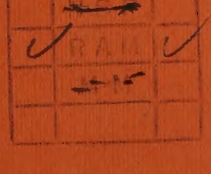
INDIAN INSTITUTE OF SUGARCANE RESEARCH
LUCKNOW

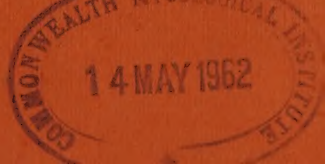
1960–61

GOVERNMENT OF INDIA

MINISTRY OF FOOD & AGRICULTURE

(DEPARTMENT OF AGRICULTURE)





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ADMINISTRATION

During the year under report, Shri R.R. Panje, continued as Director of the Institute. All the sections of the Institute, namely, Agronomy, Agricultural Chemistry and Soil Science, Physiology, Agricultural Engineering, Mycology and Entomology continued to function during the year as hitherto; the Gur and Khandsari Scheme however, operated as a part of the Institute only upto 2nd August 1960 from which date, its control was transferred from this Institute to the National Sugar Institute, Kanpur. The research work on the biology and control of the beetle grub at Dalmianagar was completed.

The names of the officers in-charge and the staff of the various sections of the Institute and the Gur and Khandsari Research Scheme and the research staff engaged in the work on the beetle-grub at Dalmianagar are given on pages 3 and 4 of the report.

Appointments.- Against the total sanctioned strength of 13 gazetted officers and 184 subordinate staff at the beginning of the year, the strength at the close of the year ended 31st March 1961 was 11 gazetted officers and 170 subordinate staff. On the termination of the work of beetle grub at Dalmianagar, Shri J.P. Kulshreshtha, Assistant Entomologist was transferred to the post of Senior Research Assistant, Class II non-gazetted. Later, he left the Institute, and joined as Entomologist in one of the schemes under Indian Council of Agricultural Research.

Schemes financed by the Indian Central Sugarcane Committee.- The sanction of the Government of India existed for the following schemes during the year 1960-61.

1. All-India Coordinated Scheme for Research on the control of Rust Disease;

2. Scheme for Coordination of research work on Insect Pests;

3. Scheme for the Establishment of 5 Entomological Outposts;

4. Scheme for Studies on the Physical and Chemical Criteria of Gur leading to the formulation of basis of Gur Grades;

5. Gur Storage Scheme.

The work in the schemes for control of Rust Disease, and coordination of research work done on Insect Pests was continued. In the scheme for Entomological Outposts, one more Outpost, viz. the fourth, was established. The fifth Outpost in Assam could not be started, since one of the candidates selected by the Union Public Service Commission failed to join. The Gur Grading and Gur Storage Schemes were fully implemented with the joining of the Gur Chemist on 25th July 1960; the full complement of staff as sanctioned by the Indian Central Sugarcane Committee could not be engaged on the two gur schemes for want of corresponding sanction from the Government, and therefore the schemes were run with limited personnel. Although the scheme on Phosphorus and Trace Elements Nutrition and Fertilisation was earlier approved by the Indian Central Sugar-

cane Committee and adequate provision was made in the budget of the Government of India, subsequently the Committee expressed its inability to provide the funds for it during 1960-61. As such the Scheme could not be implemented.

As against a total sanction of 2 gazetted officers and 34 subordinate staff in respect of the schemes financed by the Indian Central Sugarcane Committee during 1959-60, the total strength during 1960-61 was 2 gazetted officers and 32 subordinate staff.

Budget.- The budget of the Institute proper for the financial year 1960-61 was Rs.6,40,000. In addition, a grant of Rs.75,000 for capital expenditure was sanctioned during the year. The schemes financed by the Indian Central Sugarcane Committee had a total budget of Rs.2,32,000. This amount is recoverable from the Indian Central Sugarcane Committee. With these, the total budget of the Institute including Capital Outlay was Rs.9,47,000 as against Rs.12,00,000 during 1959-60. The reduction is mainly due to the termination of the Beetle Grub work at Dalmianagar and the transfer of the Gur and Khandsari Scheme to National Sugar Institute, and lesser grant for Capital expenditure.

Visitors.- A number of Central and State Government officers, certain visitors from abroad, sugarcane growers, students and parties interested in sugarcane agriculture and the manufacture of Gur and Khandsari sugar visited the Institute.

STAFF

Director	Shri	R.R. Panje.

Agronomy

i) Research

Assistant Agronomist (Class II)	"	P.S. Gill.
Research Assistant	"	Masood Alam.
Research Assistant	"	N.S. Katole (from 10-10-60 to 16-11-60).
	"	M.P. Motiwale (from 3-12-60).
Research Assistant (Chemical)	"	Bakhtawar Singh.
Scientific Assistant	"	S.R. Seth (till 15-12-60).
	"	K.C. Pathak (from 16-12-60).
Scientific Assistant	"	S.R. Seth (from 16-12-60).
Scientific Assistant	"	J.P. Misra.

ii) Farm and General

Farm Superintendent	"	Suba Singh.
Assistant Farm Superintendent	"	Rajendra Singh.
Agricultural Inspector	"	B.S. Hora.
Agricultural Inspector	"	M.P. Kanaujia.
Agricultural Inspector	"	Ranvir Singh (from 11-4-61).
Draftsman	"	S.P. Nigam.

iii) Statistics

Statistical Assistant	"	R.S. Srivastava.
Computor	"	S.B. Lal Shukla.

Agricultural Chemistry & Soil Science

Soil Chemist (Class I Junior)	Dr.	Ambika Singh.
Senior Chemical Assistant	Shri	S.N. Pandit.
Senior Soil Assistant	"	S.S. Iyer.
Senior Microbiological Assistant	"	D.P. Johari.
Junior Chemical Assistant	"	S.C. Soni (till 16-7-60).
	"	Baboo Lal Dhanvi (till 31-12-60).
Junior Chemical Assistant	"	Ranjit Singh (from 16-12-60).

Physiology

Physiologist (Class I Junior)	Dr.	T. Raja Rao.
Senior Physiological Assistant	Shri	K.K. Srivastava.

Agricultural Engineering

Agricultural Engineer (Class I)	"	R.G. Menon.
Assistant Agricultural Engineer (Class II)	"	A. Subrahmanyam Iyer.
Engineering Research Assistant	"	K.N. Lahiri.
Senior Draftsman	"	B.K. Dutta.
Mechanic	"	Inder Singh.

Mycology

Mycologist (Class I)	Dr. Kishan Singh.
Assistant Mycologist (Class II)	Shri C.L. Subramanian.
Research Assistant	" V.B. Singh.
Research Assistant	" T.R. Budhraja.
Mycological Assistant	" S.P. Dwivedi (from 1-10-60).

Entomology

i) Main Section

Entomologist (Class I)	" A.N. Kalra.
Assistant Entomologist (Class II)	" P.N. Avasthy.
Research Assistant	" A.K. Mehrotra (till 17-5-61).
	" M.C. Gupta (from 30-5-61).
Research Assistant	" Sunil Kumar (till 26-4-61).
Scientific Assistant	" M.C. Gupta (till 29-5-61).
Setter and Pinner	" Triloki Nath (from 3-4-61).

ii) Beetle Grubs Control Scheme

Assistant Entomologist (Class II)	Vacant }
Research Assistant	Shri D.K. Banerji (till 31-10-60 afternoon). }*

Gur & Khandsari Research Scheme

Chemist-in-charge (Class II)	" K.S. Saxena.
Demonstration Assistant	" P.B.Lal Mathur (till 16-7-60).
	" R.P. Avasthy (from 18-7-60).
Laboratory Assistant	" R.P. Avasthy (till 17-7-60).
Laboratory Assistant	" M.L. Barman (from 8-6-60).

Administrative Section

Administrative Officer (Class I Junior)	" A.S. Charan.
Office Superintendent	" R.A. Singh.
Office Superintendent	" B.N. Sharma.
Confidential Assistant	" H.L. Khanna.
Librarian	" P.D. Pathak.

Arts Section

Senior Artist-cum-Photographer	" A.M. Dass.
Photographer-cum-Artist	" S.K. Sharma.

* Abolished with effect from 1-11-60.

TECHNICAL PROGRAMME FOR 1960-61

Agronomy

1. Studies in germination and in tillering.

   i) Germination and tillering relationships of buds on a sett.

   ii) Correlations between buds on a 3-budded sett in tillering propensity.

   iii) Effects of gradients in setts.

   iv) Effects of keeping setts before planting.

   v) Effects of different kinds of desiccations.

   vi) Effects of soaking of setts in agallol solution.

   vii) Effects of cutting 3-budded setts in various ways.

   viii) Effects of apical dominance in whole canes.

2. Studies on growth.

   i) Effects of application of gibberellic acid to sugarcane.

3. Studies in water conservation.

   i) Effects of polyethylene film as mulch on germination of cane.

   ii) Effects of chopped cane trash mulch laid in different ways in cane crop.

   iii) Comparison of various kinds of agricultural wastes as mulching material.

4. Studies on cultural practices and cultural systems.

   i) Effect of different methods of planting on yield and quality of sugarcane.

   ii) Intercropping opium-poppy with sugarcane.

5. Fertilisers and manures.

   i) Assessment of Complesal-Supra as a fertiliser for sugarcane.

6. Studies in ripening.

   i) Progress of ripening in sugarcane crops.

   ii) Ripening of varieties in relation to time of planting.

7. Varietal work.

i) Seedlings.

ii) Preliminary test of seedling varieties 1959-batch.

iii) Final test plot.

iv) Trial of varieties.

v) Large-scale trial of promising varieties.

vi) New arrivals.

vii) Despatch of canes.

viii) Live herbarium.

Agricultural Chemistry and Soil Science

1. Comparative cumulative effects of manures and chemical fertilisers on sugarcane crop and soils.

2. Studies on modus operandi of green manure.

3. Soil plant relationship of potassium in sugarcane soils of India.

4. Nutritional studies on sugarcane.

5. Studies on nitrogen transformation in sugarcane soils.

Physiology

1. Studies on nitrogen nutrition.

2. Studies on phosphorus nutrition.

3. Biochemical basis of resistance to red rot.

4. Studies on the prevention of flowering.

5. Studies on germination.

Agricultural Engineering

1. Study and improvement of agricultural implements at present used for sugarcane cultivation in different regions.

2. Field testing of sugarcane implements designed and manufactured in the country by private agencies or imported from abroad.

3. Designing and fabricating improved bullock-drawn and tractor-drawn implements and other machinery for sugarcane cultivation.

4. Devising ways and means of conserving irrigation water.

5. Exploring possibilities of over-head irrigation of sugarcane.

6. Mechanisation of sugarcane cultivation.

7. Collaborative conduct of long-term experiments on important cultural operations.

8. Designing and testing of improved plant and machinery for use in the manufacture of khandsari sugar.

Mycology

1. Studies on the nature of red rot resistance in sugarcane.

2. Assessment of the comparative reaction of sugarcane varieties to red rot infection by plug and nodal methods of inoculations.

3. Comparative behaviour of varieties in relation to the life cycle of cane and biotypes of the red rot pathogen.

4. Studies on deterioration of juice-quality, due to red rot.

5. Investigations of the efficacy of fungicides against leaf mid-rib lesions to red rot.

6. Assessment of comparative response of sugarcane varieties to smut infection by artificial inoculation.

7. Studies on physiologic specialisation in smut organism.

8. Observations on twisted top and albino diseases.

Entomology

1. Studies on toxicity of different insecticides in relation to major sugarcane pests.

2. Studies on some promising parasites of sugarcane pests.

3. Study of methods for assessing pest incidence and populations.

4. Classification and maintenance of sugarcane insect fauna.

5. Studies on biology and control of stalk borer, Chilotraea auricilia Ddgn.

6. Study of behaviour of new Co. varieties towards pest incidence.

7. Studies on the biology and control of white grub, Lachnosterna consanguinea Blanch at Dalmianagar.

Sugarbeet

1. Trial of sugarbeet varieties.

2. Studies to find out the optimum time of sowing sugarbeet.

3. Studies on the effect of method of sowing and spacing on the yield of sugarbeet.

4. To work out the manurial and irrigational requirements of sugarbeet.

5. To explore possibilities of seed production in sugarbeet.

6. Coordinated trials at various centres in India.

i) Varietal trial.

ii) Time of sowing.

iii) Method of sowing.

iv) Seed production.

SUMMARY

General.- Weather conditions were favourable to the crop, but untimely rains and cyclonic winds in October lodged the heavy crop, and reduced the yields of sugarcane by about 25 per cent to 48.21 metric tons per hectare. Stalk borer was severe in the October-planted crop.

Agronomy.- It was found that the germination of any one bud in a 3-budded sett was fairly associated with the non-germination of its neighbour, especially when the remaining one failed to germinate. Correlations between adjacent buds in tillering were small and negative. Among the many findings in germination-gradient studies, the important were that whatever the number of buds on a sett, the best germination and tillering are in the 2nd bud, and the poorest in the bottom-bud; that the 3-budded sett has a higher mean bud-capacity than setts with larger number of buds, but the total output of clump per bud was greater in setts with a larger number of buds; and that termites were a little more partial to the top-end buds than to the bottom-end ones.

An important finding of the year was that dryage or staling of seed-cane has a beneficial effect on germination, provided cane is soaked after the dryage; another was that for seed-cane, soaking for periods like 8 hours overnight etc. was harmful and that the best was 2-4 hours, depending upon the condition of cane; a third was that water in the setts is itself adequate for a high rate of germination provided it is conserved. Waxol coating afforded only a slight protection against evaporation losses from the sett. Soaking in agallol solution for 3 hours expedited germination decidedly better than dipping. Cutting the sett at the wax-band instead of at the middle of the internode made little difference to germination capacity. Apart from apical dominance, there was an indication that alternate buds germinate when whole canes are planted; also that top-buds germinated and tillered better when whole canes were kept for 36 hours after harvest.

Application of gibberellic acid in the hollow of the leafsheaths increased the rate of growth of the stalk temporarily; in the subsequent period, treated stalks showed lesser rates of growth; the effect varied with age of stalks. These reactions were reflected on leafsheaths and internodes. Girth of stalks was slightly more in treated stalks of October- and February-planted crops, but in the May-planted, the control was mostly better.

In water conservation studies, germination of cane was found accelerated multifold by using polyethylene film as soil cover; the life of the film, however, is uneconomically short. Soil temperatures in summer were lower and moisture content higher where the soil surface was mulched with chopped cane trash. Pre-emergence laying of trash mulch slowed down germination of early planted cane; post-germination application increased tillering and crop-condition, but the differences on yield were finally non-significant. Different agricultural waste materials used as mulches in furrows made no difference to the crop. Planting in shallow-trenches was slightly better than on flat, and water was greatly conserved.

In experiments on method of planting with and without irrigation immediately after planting, the results were mostly non-significant. Sugarcane planted after a crop of opium-poppy gave an unsatisfactory yield.

The fertiliser Complesal-Supra was on a par with ammonium sulphate in cane-yielding capacity.

In studies on ripening, October-planted crops were found to start the season with the best juice-quality, followed by ratoons, and by February-planted and May-planted crops up to December. They are superseded by ratoons in January, and by February-planted cane in February. Relevant parts of the above results were confirmed in another experiment covering different varieties planted in October and February. Speed of ripening differed with varieties; being highest in Co.1111 and lowest in Co.453.

9,831 seedlings comprised of 13 crosses received from Coimbatore were transplanted. Only 253 survived the dryage in transit, and a hailstorm which followed transplantation. 30 seedling varieties have been selected out of the 110 of the 1959-batch. Out of the 84 varieties in the final test plot, 7 have been raised to Co.-status and supplied to research stations in north-central and north-eastern India. The new system of supply of varieties to State stations from Lucknow has ensured triple advantage of local selection, larger quantities of seed-cane per variety and expeditious delivery of material to concerned stations. In the varietal trial, Co.785, Co.1254, Co.1305, Co.1306, Co.1308 have been found promising. N.Co.291 and N.Co.351 failed to come up to expectations; C.P.29/320 had an exceptionally good juice-quality in November, but the variety was seriously liable to root rot. In a large-scale trial, Co.1158 showed very good stands and very satisfactory general field behaviour.

Statistics.- Designing, analysis and interpretation of the field experiments continued to be the main work in the Statistics Section.

In a special analysis on germination of the buds, it was found that the germination per cent for a cane stalk does not depend on the number of buds which the stalk possesses.

It was found that for small samples also, the analysis of variance on the number of shoots in clumps should be performed by the transformation which is valid for large samples.

Analysis of sugar recovery figures from the factories in the various parts of the Indian Union for 1960-61 season has shown the trend of recovery followed the cubic curve for West Bengal, Mysore and Pondicherry and for the rest of the tracts it was quadratic.

Agricultural Chemistry and Soil Science.- The field experiment on the *modus operandi* of green manure of sugarcane in north India has shown that there is good response of sugarcane to *sanai* green manure, but a response of about the same order can be secured either by applying 67 kg. of nitrogen per hectare as ammonium sulphate or by burning the

above-ground parts of sanai and applying the ash to cane crop. No residual effect of sanai green manure was found to exist in terms of soil nitrogen or organic carbon.

Aqua ammonia gave a response of approximately .82 quintals per kg. of nitrogen. Sugarcane did not respond to potassium sulphate applied at 28 to 168 kg. per hectare K_2O.

No response of sugarcane crop (Co.S.510) was obtained to superphosphate upto 336 kg. per hectare applied in bands at a distance of 15 cm. on both sides of the sett at a depth of about 7 cm.

The leaf-yellowing disease of sugarcane in Co.527 at the Institute farm was diagnosed as being caused by manganese deficiency. The levels of manganese in different tissues of affected plants were determined. Spraying the affected plants with 125 ppm. solution of manganese as manganous sulphate brought down the symptoms by 50 per cent. Leaf-yellowed plants showed lower brix, sucrose and purity, but when they were sprayed with 125 ppm. manganese solution they showed improvement in juice-quality. The manganese deficiency appears to be caused by the high calcium content of the soil and its poor drainage during the monsoon period.

Studies on the colour of gur have shown that apart from the varietal effect, contact with iron while crushing the cane and boiling the juice also has a pronounced effect on the colour. The experiment has established that very light-coloured gur can be prepared by selecting appropriate varieties and eliminating contact of cane and juice with iron during the processing.

Studies on the nature of unproductive soil patches on the farm have shown that there are two types of patches. Certain of the patches are produced by loss of the top soil due to erosion or levelling. The other patches are alkaline in nature. Treatments for their amelioration have been drawn up.

It has been found that manitol, glycerol, glucose and sucrose are excellent energy sources for Rhizobium strains of gram, pea, sanai and dhaincha. Galactose and arabinose were found to be inferior. Dextrin and inulin are also good sources, but when they are employed as energy sources the medium turns alkaline after the bacterial growth.

Application of gamma BHC to the soil at the rate of 1 ppm. has been found to reduce the total bacterial population as well as Azotobacter population. This casts doubt on the claim that gamma BHC stimulates soil microbes, especially Azotobacter.

Physiology.- Experiments to assess the optimum nitrogen index of sugarcane on the basis of Clements's crop-logging system, as applicable to north Indian conditions have indicated that the nitrogen level in the concerned index tissue should be maintained between 1.62 to 1.87 per cent up to September. A wide range of nitrogen, 1.15 to 2.23 per cent in the index tissue was secured by growing the

crop at various levels of fertiliser from 0 to 340 kg. nitrogen per hectare. Maintenance of the nitrogen at an index level higher than 1.87 per cent failed to produce any increase in the output of sugar; whereas maintenance at a lower level than 1.62 per cent was observed to affect cane yield adversely. Also, no useful purpose appears to be served by logging the crop for nitrogen after September.

In corresponding studies on phosphorus nutrition of cane, phosphorus levels in the index tissue of crop fertilised at various dosages from 0 to 340 kg. P_2O_5 per hectare were worked out from May to January. The level of phosphorus in the index tissue ranged from 0.126 to 0.185. Within this range of phosphorus index, the yield of the crop was not affected. The critical level, therefore, could not be established.

Studies on the nitrogen metabolism of the two strains 'D' and 'I' of the red rot fungus have shown certain differences in the metabolic products formed in their culture media.

Experiments conducted to prevent flowering in Co.1207 and Co.1062 have indicated that a total suppression of flowering can be achieved in these varieties by defoliating the stalks in the 3rd or 4th week of September.

Studies on moisture content of setts showed that the water in the setts moves towards the buds during germination. The moisture in an internode (with node) has been found to be ordinarily sufficient for the germination of its bud.

Agricultural Engineering.- In the further trials conducted this year with the blade-harrow, it was observed that in interspaces heavily infested with weeds the blade tended to become clogged, and when thus clogged, it either failed to give satisfactory penetration or failed to pull out weeds efficiently. A modified design showed marked reduction of clogging, both on the blade proper and in the region of the vertical supports.

A medium-scale field trial with the IISR bullock-drawn sugarcane planter showed that a team of 9 men and one pair of bullocks can easily plant 1.62 hectares (4 acres) of sugarcane in an 8-hour day, at a cost of Rs.11.55 per hectare (Rs.4.62 per acre). The manufacturing rights for the above planter have been assigned by the National Research Development Corporation to two commercial firms, who are being given technical guidance in the manufacture of the planter. This Institute is also in touch with the users of the implement.

In the 2nd year durability tests with the transparent lay-flat polyethylene tubes for conveying irrigation water, it was found that so many pin-hole punctures developed that repair became quite a problem. Black tubular film will now be tried.

Preliminary studies on the penetration of irrigation water under flood and trench systems of irrigation were made. The results were however inconclusive as the soil wetted by the applied irrigation water could not be clearly demarcated on the soil profile in test pits.

Tests on the Land Master Tropical Tiller conducted with a view to mechanising sugarcane cultivation on small holdings showed that this machine can be profitably used only for such light cultivation operations as inter-row cultivation, fertiliser drilling and insecticide spraying.

For collecting composite samples of juice in small quantities from standing cane for the purpose of micro-analysis and for estimation of brix with a hand refractometer, a compact, efficient and low-cost cane-juice sampler was designed and manufactured. Tests showed that the imstrument is easy to handle and to clean, and that chances of evaporation from samples are minimum.

An instrument for quickly making circular peripheral incisions of predetermined depths on cane setts without cracking, splitting or otherwise damaging the rind was designed and fabricated to meet requirements of agronomical, physiological and mycological research on sugarcane.

The conventional sugar centrifuge with modifications in design was tested in experiments on continuous removal of mud from sulphited cane juice, in continuation of earlier studies. Excessive oscillation in brief spells during acceleration called for minor modifications; these are being effected.

Mycology.- Comparative studies on 34 isolates of red rot fungus on 10 standard varieties indicate that the strains differ in their virulence. Red rot isolates cultured on graded doses of sucrose, iron and zinc showed that beyond a certain level of sucrose, growth is retarded; iron and zinc are utilised only in traces. In susceptibility tests by plug method, on 150 varieties of sugarcane, Co.1060, Co.1100, Co.1152, Co.1216, Co.1236 and B.0.3 were assessed as moderately resistant, and Co.312, Co.1154, Co.1156, Co.1168, Co.1180, Co.1200, Co.1232, Co.1246 and Co.1252 as highly susceptible; in nodal resistance tests on 140 varieties, Co.969, Co.1054, Co.1213, Co.1215, Co.1217, B.0.9 and B.0.14 were assessed as resistant. Deterioration of juice-quality due to red rot was maximum in Co.312 and Co.527 in 100 days and in others 137 days after inoculation. There is no consistent association of degree of red rot infection with age-differences between stalks. Evidence was gathered that mid-rib lesions usually do not play a part in the natural spread of red rot disease.

Of 41 promising varieties tested by artificial inoculation against smut, Co.449, Co.617 and Co.947 came out as resistant. In studies on physiologic races of smut, linear growth of the fungus did not appear to be the only criterion for race differentiation. Inoculation of cane buds under vacuum gave high rate of infection better than the immersion of setts in spore suspension. In nutritional studies on smut fungus, asparagin yeast agar was found the best medium; the optimum temperature and pH were 28°C and 5.6 respectively.

Natural recovery after successive vegetative generations has been observed in twisted top affected canes. The identity of albino disease in relation to grassy shoot

together with its control by heat-treatment are being investigated.

Pythium aphanidermatum was found to cause the clump dryage of C.P.29/320 and was found to be associated with certain plant parasitic nematodes. Fytolan drenching has effectively checked the disease.

A preliminary survey of the occurrence of plant parasitic nematodes on sugarcane has been made from 8 States by collection and examination of soil samples; the nematode populations were assessed and identified and their association with other fungi determined.

Entomology.- In laboratory studies on toxicity and persistence of 0.1 per cent endrin spray in relation to newly-hatched larvae of C. auricilia, 100 per cent mortality was observed even when the larvae were exposed to the treated surface up to 26 days after treatment. In a study of comparative toxicity of different insecticides to grown-up larvae only chlorcide/malathion emulsion in 0.2 per cent strength gave complete mortality 24 hours and 48 hours after exposure, respectively when the larvae were released on the treated surface immediately and 24 hours after treatment; with a 0.1 per cent emulsion and with endrin 0.1 and 0.2 per cent complete mortality was obtained 192 hours after exposure.

Trials on the chemical control of C. auricilia and P. indicus did not yield any conclusive results. A pathogenic bacterium, Bacillus cereus var. thuringiensis (Berliner) was also tried for the control of these borers but without success.

Soaking of seed pieces for 2 hours in endrin, basudin and BHC + DDT in 0.1 per cent emulsions and in dipterex 0.2 per cent solution resulted in almost complete mortality of the C. auricilia larvae within. Only dipterex soaked cane gave as good germination as the water-soaked. The rest affected germination adversely.

Among systemic insecticides, soil application of metasystox 0.2 per cent emulsion resulted in 100 per cent mortality among the caterpillars of C. infuscatellus within the shoots of the standing crop. Foliar application of phosdrin 0.2 per cent emulsion and of granular endrin at 13.5 kg. per hectare also gave good results.

Observations on different parasites of sugarcane pests at the Institute farm in August, 1960 revealed high parasitisation of top borer larvae by M. ornatipennis, R. scirpophagae, E. zehntneri and Iphialax sp. Efforts to rear M. ornatipennis and R. scirpophagae in the laboratory did not succeed.

Laboratory breeding of Trichogramma evanescens minutum Rilley was attempted with a view to its release in the fields against C. auricilia. The parasite could not be multiplied because of 'super-parasitism' which was observed to occur in almost all Corcyra eggs parasitised by the adult Trichogramma wasps in the laboratory.

Efforts to breed L. diatraea, an exotic parasite of sugarcane borers in the laboratory at Lucknow also did not succeed.

In block trials on the chemical control of white grub, L. consanguinea at Dalmianagar (Bihar), two applications of BHC (dust) each at 11.2 kg. actual per hectare in June and in July gave good results.

Sugarbeet.- Experiments to assess the possibility and broad economics of sugarbeet cultivation under Indian conditions were carried out at 8 centres viz., Jullundur, Karnal, Muzaffarnagar, Shahjahanpur, Lucknow, Gorakhpur, Pusa and Mandya and small sowing tests at 10 centres located in various parts of the country, with seed procured from East and West Germany, the U.S.S.R. and the U.S.A.

In the varietal trial conducted at Indian Institute of Sugarcane Research with 16 varieties, Ero gave the highest yield of 32.84 metric tons of roots per hectare followed by US-H_2, Ramonskaya and Polyro. The yield of high-sugared varieties viz., "Z" and "ZZ" was comparatively low. On the average the sugar content was about 15 per cent. US 22/3, US 35 and Interpolybeta had about 21 per cent in the roots.

1st October sowing gave slightly higher yield than the subsequent sowings done at fortnightly intervals. Sowing on ridges showed slightly better yield and sugar content that on flat. Spacings between 38.1 to 53.3 cm. did not influence yield, but wider spacings tended to show higher sugar content.

112 kg. N per hectare gave markedly higher yield than 56 kg. and this in turn was better than the control. The higher doses of nitrogen showed a depressing effect on sugar content. The higher yield got with 7 irrigations over 5 irrigations was not significant.

Superphosphate at 44.5 kg. per hectare did not influence either the yield or the quality of roots.

In the coordinated experiments, on the average, variety Ero gave the highest yield; it was followed by Ramonskaya. The sugar content was highest on an average in US 35, Polyro and US 75. In the cultural trials, as observed at Lucknow, early sowings in October and sowing on ridges gave good results.

MAIN REPORT

GENERAL

The weather conditions during 1960-61 were on the whole favourable for sugarcane. In May and June 17.5 mm. of rain was received. The actual monsoon started in time, and the rains though excessive were well distributed. In October, however, 256 mm. of rain, accompanied by fast winds was received. The total rainfall of 1332 mm. was about 300 mm. in excess of the normal (Table 1).

The area under cane at the Institute during the year was 33.5 hectares* (82.8 acres) including about 5.78 hectares (14.3 acres) under ratoons. Plantings were done timely and germinations were mostly over 60 per cent. There was a severe incidence of stalk borer in the autumn-planted crop, whereas the infestation was mild in the spring-planted one. A slight post-monsoon infestation of pyrilla appeared in the crop; this was quickly controlled. Continuous cloudly weather during the rainy season resulted in a fairly extensive top-rot infection, in which Co.951 suffered to a noticeable extent. In the untimely rains and winds which were received in October, the heavy and well-grown crop raised at the Institute lodged badly and the yield suffered; due to late rains, ripening was also delayed to some extent. The average yield of cane was 48.21 metric tons per hectare, no allowance being made for spaces left in experimental planting.

AGRONOMY

1. Studies in germination and in tillering

i) Germination and tillering relationships of buds on a sett.- During the year, the associations and interactions between the germination of successive buds of the standard 3-budded sett were studied. The purpose of these studies was to find out how far the germination and tillering of any one bud of the 3-budded sett affected the germination and tillering of the other buds, and whether there was any scope for improving the overall germination capacity and output of the sett. The results showed interesting relationships.

In the spring-planted crop, the association between the 1st and the 2nd bud, and that between the 2nd and the 3rd bud were both negative and highly significant. This means that when one of the two buds germinates, there is a tendency for the other not to germinate. Such an association however, does not exist between the 1st and the 3rd bud. When the 3rd bud fails to germinate, the coefficient of association between the 1st and 2nd buds rises from -0.4507 to -0.7071; similarly, when the 1st bud fails to germinate the association of germination between the 2nd and the 3rd buds rises from -0.5325 to -0.7811; and finally,

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* Equivalents for conversion purposes as between metric and other units are given in Appendix 1.

TABLE 1

Meteorological data for 1960-61
as recorded at the Indian Institute of Sugarcane Research, Lucknow.

Calendar months		Average maximum temperature °C	Average minimum temperature °C	Average per cent relative humidity			Average soil temperature °C			Rainfall in mm.	Number of rainy days	Average wind velocity mph.	Average evaporation for 24 hrs. (Piche's reading in cc.)	Total hours of sunshine
				Morning (7.06 hrs.)	Evening (14.06 hrs.)	Mean	5 cm. depth	15 cm. depth	30 cm. depth					
June	1960	40.7	29.4	59.8	38.9	49.3	38.6	37.0	37.0	9.5	2	4.70	19.2	225
July	1960	32.9	26.5	84.0	73.7	78.8	31.4	31.1	31.5	593.4	19	3.39	5.9	156
August	1960	32.2	26.3	91.5	78.3	84.9	31.3	31.0	31.2	321.4	22	2.11	3.1	172
September	1960	32.7	25.3	88.5	62.9	75.7	32.7	31.4	31.4	104.2	6	2.35	3.9	239
October	1960	31.3	19.7	90.0	53.5	71.7	28.0	27.3	28.0	256.0	4	1.49	4.3	258
November	1960	28.0	10.9	88.0	28.2	58.1	21.3	20.9	22.2	Nil	Nil	1.32	6.0	294
December	1960	24.4	8.2	91.6	32.2	61.9	16.9	16.6	17.7	Nil	Nil	1.46	4.9	265
January	1961	21.9	8.0	94.2	46.5	70.3	16.5	17.3	16.8	23.8	3	1.80	3.9	242
February	1961	22.8	9.4	78.9	39.3	59.1	18.1	16.8	17.3	19.5	4	3.72	7.3	241
March	1961	32.3	14.9	63.0	16.7	39.8	26.2	23.9	23.8	Nil	Nil	3.30	14.2	293
April	1961	37.7	20.3	45.8	14.0	29.9	31.7	29.4	28.8	Nil	Nil	4.16	20.5	302
May	1961	41.3	25.8	44.2	17.2	30.7	37.3	35.6	34.6	4.5	2	4.13	20.5	323
Total		-	-	-	-	-	-	-	-	1332.3	62	-	-	3010

if the 2nd bud does not germinate, the association between the other two buds, otherwise absent, becomes perceptible (-.5499) and significant.

TABLE 2

x^2 values and Coefficients of association between germination of buds of a 3-budded sett

Germination as between	Autumn-planted		Spring-planted	
	x^2 value	Coefficient of association	x^2 value	Coefficient of association
1st and 2nd buds	0.038 (1)	-.0198	33.63** (1)	-.4507
2nd and 3rd buds	2.253 (1)	-.1490	54.29** (1)	-.5325
3rd and 1st buds	1.540 (1)	-.0985	0.19 (1)	-.0283
1st and 2nd buds when 3rd bud fails to germinate	11.70** (1)	-.5248	40.82* (1)	-.7071
2nd and 3rd buds when 1st bud fails to germinate	19.77** (1)	-.6487	51.73* (1)	-.7811
1st and 3rd buds when 2nd bud fails to germinate	21.25**	-.7289	14.55**	-.5499

* Significant at 5 per cent level
** Significant at 1 per cent level

The results differ to some extent with autumn-planted cane. There is no association in the germination of any two buds, when considered independently of the remaining bud. However, when any one bud fails to germinate, the association between the germination of the two remaining buds becomes highly significant and negative; the coefficients being -.5248, -.6487 and -.7289 under conditions of non-germination of the 3rd, 1st and 2nd buds respectively (Table 2).

Association between the length of the top cut-internode and the germination of the 1st bud is significant in the autumn-planted crop; as expected, this association gets stronger with spring-planted crop. Such an association is absent between the bottom-end cut-internode and the 3rd bud in autumn-planted crop, whereas this association is highly significant in spring-planted one.

Tillers on the 1st bud and the length of top-end cut-internode showed a positive and significant correlation in spring-planted crop. There was no such correlation between the 3rd bud and the length of the bottom-end cut-internode.

Similar association/correlation was absent between germination of tillers on the 1st bud and the length of the 1st full internode.

ii) Correlations between buds on a 3-budded sett in tillering propensity.- Correlations between the numbers of tillers arisen from any two buds on a 3-budded sett were low and in almost all cases non-significant, where the germination of the remaining bud was not taken into account; such little correlation as there was between successive buds was negative, and between the 1st and 3rd buds almost non-existent. Where the remaining bud failed to germinate, the correlations were slightly higher but still quite low, and almost all were significant (Table 3).

TABLE 3

Correlations between the amount of tillering from the buds of a 3-budded sett

Tillers as on	Autumn-planted	Spring-planted
1st and 2nd bud	- 0.1592	- 0.1845
2nd and 3rd bud	- 0.2324*	- 0.1549
1st and 3rd bud	+ 0.0064	- 0.0791
1st and 2nd bud when 3rd bud fails to germinate	- 0.2073*	- 0.2262*
2nd and 3rd bud when 1st bud fails to germinate	- 0.3383**	- 0.3048**
1st and 3rd bud when 2nd bud fails to germinate	- 0.2276*	- 0.1087

* Significant at 5 per cent level
** Significant at 1 per cent level

iii) Effects of gradients in setts.- Studies conducted last year on comparative germination and proliferation capacities of different buds on a standard 3-budded sett (vide Annual Report 1959-60) showed inter alia that the 2nd (i.e. middle) bud possesses a distinct advantage over the end buds. Further studies were taken up to find out the effects of gradients in setts with larger numbers of buds, viz., 3-, 4- and 5-budded setts. 150 setts of each type, using Co.S.510 were planted on 9th March, 1961, and a study of the germination and clump-formation of the successive buds was made.

The germination trend in the 3-budded sett is the same as was seen last year on Co.951. But the percentages are as a whole lower this year; this is probably due to the change of variety.

TABLE 4

Comparative germination and tillering capacities etc. of buds on 3-, 4- and 5 budded setts

Sett	Capacity of buds (Counting from top-end of setts) 1st bud	2nd bud	3rd bud	4th bud	5th bud	Mean
i) Germination capacity						
3-budded	50.0	60.0	30.6	-	-	46.9
4-budded	46.0	59.3	42.0	23.3	-	42.6
5-budded	50.7	51.3	45.3	44.0	26.0	43.5
ii) Average number of tillers arisen per bud						
3-budded	7.7	7.8	7.0	-	-	7.5
4-budded	8.0	9.2	7.8	8.1	-	8.3
5-budded	7.6	8.9	7.6	8.1	6.7	7.8
iii) Average dry weight of clump arisen per bud, in g.						
3-budded	60.5	63.2	52.8	-	-	58.8
4-budded	71.1	79.0	61.8	57.8	-	67.4
5-budded	66.9	90.7	68.8	63.4	60.0	70.0
iv) Average dry weight per shoot arisen per bud, in g.						
3-budded	7.9	8.1	7.5	-	-	7.8
4-budded	8.8	8.6	8.0	7.1	-	8.1
5-budded	8.8	10.1	9.1	7.8	8.9	8.9
v) Percentage termite damage to buds						
3-budded	21.3	5.3	16.7	-	-	14.4
4-budded	22.0	8.0	4.7	20.0	-	13.7
5-budded	21.3	8.7	4.7	4.7	19.3	11.7

In all the three types of setts (3-, 4- and 5-budded), the 2nd bud gave the highest germination followed by the 1st bud (Table 4). The germinations of 3rd bud of the 4-budded setts and the 3rd and 4th buds of the 5-budded setts were more or less similar. The bottom buds of each type of sett gave the lowest germination.

Taking the overall average, the 3-budded sett gave slightly better germination than the 4- and the 5-budded setts. The reasons for this are not clear.

In tillering also, the 2nd bud maintained its advantage over the rest of the buds (Table 4). The bottom buds, as observed in germination, produced less tillers

than the other buds except in the 4-bud sett in which lowest tillering was in the 3rd bud.

The output of plant material from buds from different setts appears to bear a direct relationship with the number of buds on the sett (Table 4); the more the buds on a sett the greater the output per bud.

Dry weight per shoot of different setts followed the same trend as that of clump weight (Table 4).

The results of this experiment were greatly affected by termites, which damaged the cut-ends of a large number of setts and also destroyed many buds. As usual, the damage was somewhat patchy. As expected, the end-buds suffered the highest damage. But, the damage was seen to be slightly greater on top-end buds than the bottom-end buds, while the ones that consistently showed the least damage were the penultimate buds from the bottom-ends. For obvious reasons, the more the buds per sett, the less was the overall percentage damage.

The results further bring out that with a given total number of buds planted, germinated shoots are more with 3-budded setts, but the total plant material produced is the highest with the 5-budded setts. The advantage possessed in germination by the 3-budded setts is thus more than obliterated. The preference now given to 3-budded setts is based partly on germination percentage, partly on convenience and partly on the need for a check on disease infection etc. The present results however indicate that for at least one reason, setts with larger numbers of buds may be preferable. These results need confirmation.

iv) Effects of keeping setts before planting.- Usually there is a delay between the harvesting and planting of seed-cane and this affects the germination of buds seriously; the longer the delay, the lower the germination. Since the main cause of loss of germination is presumably the loss of water from the sett, an experiment was conducted to see whether and how far the adverse effects of the delay between harvesting and planting can be ameliorated by soaking in water. The following treatments were tried.

Seed-cane left after harvest under trash cover for			- followed by soaking in water for
0 hour (0)			0 hour (0)
24 hours (24)			1 hour (1)
48 hours (48)		X	2 hours (2)
72 hours (72)			4 hours (4)
			8 hours (8)

The experiment was planted in a split-plot design with soaking treatments to main plots and drying treatments to sub-plots in 5 replications, using 50, 2-budded setts of Co.1111 per plot. The plantings were done in the 1st week of March.

TABLE 5

Germination of fresh and stale seed-cane with and without soaking

Seed-cane subsequently soaked in water for	Per cent germination of seed-cane left under light trash cover after harvest for				
	0 hour	24 hours	48 hours	72 hours	Mean
	19 days after planting				
0 hour	10.8	2.6	1.0	0.6	3.8
1 hour	18.8	9.6	12.4	1.4	10.6
2 hours	19.8	24.6	15.4	4.2	16.0
4 hours	22.4	27.0	19.2	14.0	20.7
8 hours	15.2	16.6	18.6	24.8	18.8
Mean	17.4	16.0	13.3	9.0	13.9
LSD Staling treatments	2.4				
LSD Soaking treatments	3.1				
LSD Interaction	5.4				
	33 days after planting				
0 hour	62.0	56.0	50.0	50.6	54.7
1 hour	62.2	62.0	64.8	53.6	60.7
2 hours	65.6	65.6	58.8	56.0	61.5
4 hours	64.4	63.6	66.2	64.8	64.8
8 hours	60.6	65.4	63.2	63.4	63.2
Mean	63.0	62.1	60.6	57.7	60.9
LSD Staling treatments	3.5				
LSD Soaking treatments	3.5				
LSD Interaction	Non-significant				

While with an increase in the period of drying, the setts showed a progressive decline in germination, when the dried material was soaked in water, there was marked amelioration of this adverse effect (Table 5). On the 19th day after planting, one hour's soaking nearly obliterated the adverse effect of 24 hours' dryage, but 2 hours' soaking enabled the dried cane to surpass the germination of fresh cane, and even of fresh cane soaked

in water for the same 2 hours. Similarly 24 hours' dried seed-cane when given 4 hours' soaking showed about 5 units greater germination than fresh cane soaked for the same period.

This has brought out the remarkable indication, that drying has a role in the improvement of germination which manifests itself only when the loss of water is made good by soaking.

The experiment has yielded many other important results. It was observed that a longer period of desiccation required correspondingly longer period of soaking for counteracting the harmful effect: whereas 24- and 48-hours dried cane recovered its germination capacity with 2-4 hours' soaking, the 72 hours' dried cane required 8 hours' soaking to offset the dryage effects. Further, soaking also appears to have an optimum period, and this varies with the degree of dryage. The optimum is found to be far smaller than is now recommended; it was found that fresh cane soaked for 8 hours actually suffered in germination, and that the most beneficial period was 2 to 4 hours.

Setts dried for 24 hours and soaked for 4 hours showed significantly higher germination than fresh setts soaked for 2 hours. There was no significant difference between 24-4, 72-8, 24-2 and 0-4 treatments; however these treatments were better than fresh unsoaked setts, the difference being highly significant. On the 33rd day after planting, the differences in the above treatments narrowed down and became non-significant, but the improvement accountable to dryage persisted, showing that not merely the speed of germination, but also the capacity of germination was improved by dryage.

v) Effects of different kinds of desiccations.- The experiments reported under iv) above clearly brought out the beneficial effects of keeping seed-cane for some time after harvest before planting. In order to find out the precise causal influence, an experiment with 7 treatments (Table 6) was planted in 5 randomised blocks on 14th April 1960, using twenty 3-budded setts per plot. The experiment though conducted very late in the season, provided valuable information.

TABLE 6

Effect of different kinds of desiccation on seed-cane

Setts kept		Followed by soaking for	Per cent germination days after planting		
in	for		19	26	33
1. Shade	48 hrs.	0 hrs.	1.7	3.3	13.0
2. Shade	48 hrs.	4 hrs.	13.3	32.0	42.7
3. Sun with a light trash cover	48 hrs.	0 hrs.	1.0	3.7	8.3
4. Sun with a light trash cover	48 hrs.	4 hrs.	8.7	16.0	24.3
5. Polyethylene bag in shade	48 hrs.	0 hrs.	13.0	27.7	35.3
6. Wax-coated and kept in shade	48 hrs.	0 hrs.	18.3	32.0	43.0
7. Freshly planted	0 hrs.	0 hrs.	2.0	18.3	34.7
LSD			6.7	10.0	11.7

Now in treatments 2 and 4, water in the sett has been allowed to be lost to a greater or lesser extent through dryage, and has been attempted to be replaced (?) by soaking: in treatments 5 and 6, the loss of water has been prevented, i) by enclosing the setts in a polyethylene cover, and ii) by wax-coating the setts. It is found that this preserves the beneficial effect of keeping the setts after harvest unhampered or unsuppressed by the adverse effect of loss of water. A complete sealing-in of the sett moisture as in treatment 6 has given a racing germination which even 33 days after planting is far ahead of that of cane planted fresh. This is apparently because the wax coating has continued to prevent loss of water which presumably occurs in the sett while it is underground after planting. It is important to observe that this is fairly equalled by treatment 2. The results are being further studied.

vi) Effect of waxol-coating on the moisture-content of setts.- Waxol is an aqueous emulsion containing 12 per cent micro-crystalline paraffin or carnauba wax. The emulsion was supplied on request by the Central Food Technological Research Institute, Mysore.

To study the effect of waxol on prevention of loss of moisture from setts, a laboratory experiment was conducted in April using one 3-budded sett of Co.S.510 per treatment, replicated 6 times.

TABLE 7

Loss in weight of setts coated with waxol

Setts dipped in	Per cent loss in weight of setts after		
	24 hours	48 hours	72 hours
12 per cent waxol	4.2	7.1	9.6
6 per cent waxol	4.9	8.4	11.3
Water	5.7	9.7	13.0
Control	6.9	11.7	14.7
LSD	Not significant	1.1	1.0

6 per cent waxol to some extent checked the loss of weight of setts, the higher concentration being only slightly more effective (Table 7). A greater part of the loss in weight is presumed to be due to evaporation of water from the sett.

vii) Effects of soaking of setts in agallol solution.- Agallol has been known to have a good effect on germination of buds, and the recommended practice is to dip the setts in a 0.5 per cent solution of agallol. In order to find out if the effect of agallol can be enhanced and the practice made more economical, an experiment with 8 treatments was laid out in 5 randomised blocks,

using fifty 3-budded setts of Co.1111 per plot, in the first week of March.

TABLE 8

Germination of fresh and stale seed-cane with and without soaking in agallol solution

Treatments	Seed-cane left after harvest for				Mean
	0 hour		48 hours		
	Percentage germination, days after planting		Percentage germination, days after planting		
	21 days	35 days	21 days	35 days	
1. Fresh (untreated) setts	9.2	58.7	6.0	55.9	32.5
2. Setts dipped in 0.5 per cent solution of agallol	21.6	59.7	13.2	60.0	38.6
3. Setts soaked in water for 3 hours	31.5	59.1	27.5	58.5	44.2
4. Setts soaked in 0.5 per cent solution of agallol for 3 hours	42.5	63.7	45.9	65.2	54.3
Mean	26.2	60.3	23.2	59.9	42.4

LSD: at 21 days after planting 7.4
at 35 days after planting 6.7

At the end of 3 weeks, while fresh untreated setts gave only about 9 per cent germination and dipping in agallol gave 21.6, soaking for 3 hours in the same solution doubled the effect, giving 42.5 per cent (Table 8). That soaking alone is not the cause of this improvement is also clear from treatment no.3. This effect is maintained with a lesser margin even at the end of 5 weeks. Prior dryage in this experiment was not beneficial in the case of water soaking, and only slightly beneficial in the case of agallol-soaking.

viii) Effects of cutting 3-budded setts in various ways.- In order to assess the relative importance to the bud of the two internodes one extending above it and one below it, and to find out if the place of cutting the sett would make any difference to germination, an experiment was conducted on 4th April 1960 with two treatments, i) Setts cut on middle of internode and ii) setts cut on wax-band in 6 randomised blocks, using fresh and 24 hours' dried and subsequently 4 hours' soaked setts. The results (Table 9) show that the place of cutting made little difference to the germination whether the setts were fresh or pre-treated.

TABLE 9

Effect of cutting setts at different places on the internode

Treatment: setts cut	Per cent germination days after planting		
	17	24	31
Fresh setts			
On middle of internode	1.7	17.6	33.7
On wax-band	2.5	19.4	38.6
Setts dried for 48 hours and soaked for 4 hours			
On middle of internode	13.2	38.0	46.1
On wax-band	14.4	34.2	43.3
LSD	5.6	12.0	14.1

In another experiment, where one-budded setts were used, the wax-band cut gave 4-5 units better germination.

ix) Effects of apical dominance in whole canes.- To study the effects of apical dominance in whole cane on germination, a small experiment with fresh and 36 hours' staled canes of Co.951 and Co.997 was planted on 7th April 1961 in 5 randomised blocks, using one cane per plot.

The variation in germination-trend between the canes was so wide that the results did not lead to any indications on the precise capacities of germination of individual buds. However, it was observed that the top portion of stalks in both varieties improved in germination when kept for 36 hours after harvest. The output of the top portion buds of such canes was also greater than that of the corresponding buds of fresh cane (cf. Dillewijn, p. 70). Another feature of germination was that in canes kept for 36 hours, the germination of alternate buds was more common than in fresh canes: this was more strikingly observed in Co.997 than in Co.951. These are important indications, but require confirmation.

2. Studies on the effects of the application of gibberellic acid to sugarcane

Preliminary studies conducted on this subject in 1958-59 indicated that the effect of gibberellic acid on linear growth of cane varied with seasons. To confirm this,

TABLE 10

Effect of gibberellic acid on stalk elongation

Crop planted in	Mean elongation of shoots in cms. per day in					
	June		August		October	
	Control	Treated	Control	Treated	Control	Treated
October	1.2	2.1	1.7	1.2	0.6	0.4
February	1.5	2.8	2.5	2.0	0.7	0.5
May	1.2	2.0	3.1	2.6	0.6	0.4

To confirm this, ten plants of Co.951, each from October-, February- and May-planted crops were treated with a 100 microgram dose of gibberellic acid at weekly intervals against corresponding water-treated controls. The solution was dropped by a pipette into the hollow of the 3rd leaf-sheath each time. Linear growth was recorded in June, August and October. Length and girth of internodes and hand-refractometer Brix readings of the internodes formed under the treatments were recorded at harvest.

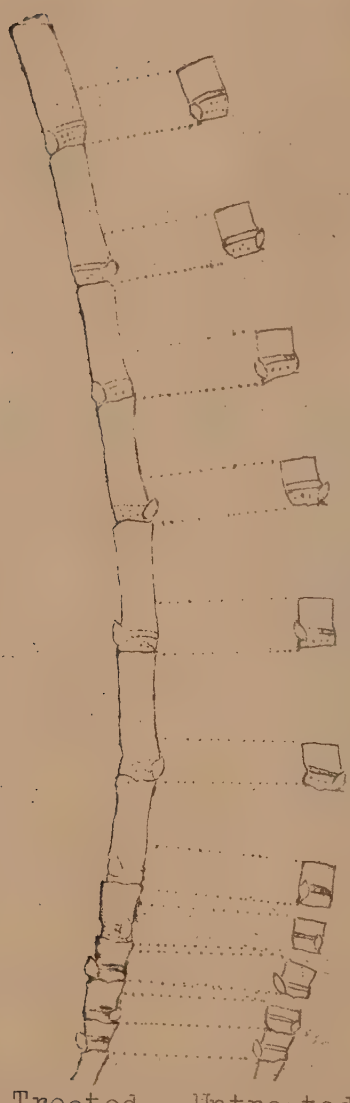


Fig.1

The results (Table 10) show that the growth-promoting effect of gibberellic acid was distinctly marked in June. In August and October, this effect was not only absent, but the treated canes were elongating at a slower rate than the control.

The effect of gibberellic acid varied with the age of the plant, October- and February-planted crops showing higher response to it in June than the May-planted crop. In August, the linear growth of the treated plants was less than that of the controls, but here also the effect was different in the three crops: in the May-planted crop the growth-rate was only slightly less than in the control, while the February- and October-planted crops slowed down much more. In October, the differences in linear growth were more or less alike in all the planting date treatments. These differences were reflected in the lengths of leaf-sheaths and internodes (Table 11 and Fig.1).

TABLE 11

Effect of gibberellic acid on cane stalks

Crop planted in.	June		August		October	
	Control	Treated	Control	Treated	Control	Treated
i) Mean length of leaf-sheaths in cm.						
October	34.6	36.7	40.3	39.9	28.3	29.6
February	29.2	32.0	37.1	34.4	33.1	24.0
May	30.3	29.9	37.8	35.4	31.9	29.6
ii) Mean length of internodes in cm.						
October	9.1	14.1	15.1	11.1	6.0	7.7
February	8.1	12.9	17.9	14.1	9.9	7.6
May	5.5	8.5	17.8	14.5	10.4	10.0
iii) Mean girth of internodes in cm.						
October	2.14	2.40	1.85	1.96	1.45	1.60
February	2.36	2.54	2.01	2.32	1.40	1.56
May	2.40	2.11	2.25	2.20	1.53	1.53
iv) Mean brix of internodes						
October	17.3	14.7	16.3	14.3	15.6	12.8
February	13.7	14.0	13.7	12.9	11.8	11.8

Unlike linear growth, application of gibberellic acid influenced the thickness of internodes favourably in all the months, in the October- February-planted crops. In the May-planted crop, the treated stalks were mostly slightly thinner than the controls (Table 11).

Internodes formed in June, August and October in treated canes had a lesser brix value by hand-refractometer than the control, particularly in the October-planted cane (Table 11).

3. Studies in water conservation in sugarcane fields

i) Effects of polyethylene film as mulch, on germination of cane.- A small unreplicated experiment was laid out with Co.951 to study the effects on germination of natural and black polyethylene film laid to cover the soil between cane rows. Each treatment plot was about 0.004 hectare in area, and the number of buds planted per treatment was 300. Planting was done on 1st December 1960.

The natural (transparent) polyethylene cover greatly increased the speed of germination in buds as compared to the black one and the control. 33 days after planting, the number of shoots which emerged from the natural cover was about 3 times as large as that from the

black cover and 7 times as large as that of the control (Table 12). In point of time, the control took more than 98 days to show about the same germination as natural polyethylene brought out in 62 days and black polyethylene in 83 days.

TABLE 12

Germination as influenced by polyethylene film as mulch on soil of autumn-planted cane

Polyethylene film	Per[illegible]tion days after planting								
	26	33	40	62	69	76	83	90	98
Natural	3.3	23.6	27.0	37.3					
Black	1.3	8.3	10.3	26.0	30.0	32.7	37.0		
Non-covered (control)	-	3.3	6.3	20.0	24.3	26.7	30.1	34.0	36.7

The rapid germination under the polyethylene covers were obviously due to higher temperature maintained and greater soil moisture preserved in the soil. Weeds grew luxuriantly under the natural film, whereas under the black cover they were few and etiolated. Later in the season (April-May) however, the crop with black film on the soil surface appeared more vigorous and had darker green leaves than that with the natural polyethylene cover; the plants of the latter had a [illegible] appearance.

The life of the black film is about twice as long as that of natural one, which hardly lasted 6 months.

The above experiment was repeated with cane planted on 20th January 19[illegible] and confirmed the earlier observations.

ii) Effects of chopped cane trash mulch laid in different ways in [illegible] - An experiment to study the effects of chopped cane trash laid in different ways as mulch after planting and on the emergence of germination, on soil moisture and soil temperature and various growth phases was conducted with [illegible] (Table 13) in 5 randomised blocks with a net plot size of 0.016 hectare, using Co.S.510.

TABLE 13

Effects of chopped cane trash mulch on sugarcane crop

Treatment		Germination per cent	Millable canes in thousands per hectare	Millable canes in thousands per hectare (thousands per hectare)	Juice-quality in December		
Planted	Chopped cane trash mulch laid				Brix per cent juice	Purity per cent juice	Purity
1	2	3	4	5	6	7	8
A. in shallow trenches	in furrows at planting	~~113.4~~ 45.9	~~127.0~~ 101.6	69.4	57.06	14.94	84.4

1	2	3	4	5	6	7	8
in shallow trenches	in furrows at planting and covered with soil	37.9	88.5	75.8	57.44	15.36	86.1
-do-	in furrows after germination	50.8	110.5	74.1	60.86	15.12	84.9
-do-	in furrows after germination and covered with soil.	50.9	96.4	75.9	63.19	15.22	85.8
on flat	on flat	46.9	117.6	75.9	60.49	15.43	86.5
in shallow trenches	Control no mulch	51.5	108.7	74.6	56.13	15.29	85.9
on flat	Control no mulch	46.2	114.1	68.7	57.18	15.07	85.6

(a) On soil moisture and soil temperature.- At planting, the two treatments, viz. A and B were applied. Of these, A continuously maintained a higher soil moisture content and a lower soil temperature (at sett level) than B and the Controls F and G during germination phase. B recorded the lowest soil moisture; this may be due to the sandwiched cane trash absorbing moisture from soil and thus depleting of soil moisture in the sett region. During the first six weeks of planting, F recorded both higher soil moisture and higher soil temperature than G.

On the completion of germination, treatments C D and E were applied. C in general maintained a higher soil moisture level, followed by D. It also lowered the soil temperature. Trash laid at planting does not seem to be as effective as the one laid on completion of germination. Treatment F (furrow-planted Control) recorded low soil moisture during April-May and the soil temperature were also highest in F and G.

(b) On germination.- Trash cover hindered germination; it was about 5 per cent lower than in the Control. There was however no difference in germination of the former treatment and that of G (flat-control). The deleterious effect of trash cover became more marked when a soil cover was laid on the top of the trash cover, the reduction in germination was about 13 per cent as compared to F (furrow-control). These results show that laying of trash cover is not necessary when plantings are done timely.

(c) On tillering.- Laying of trash after germination tended to promote tillering slightly, but the soil cover on the trash cover, affected tillering adversely.

of the treatments, B recorded the lowest shoot number preceded by D; the former treatment gave about 8000 less shoots per hectare than the latter and 20-26000 than the Controls (F and G). But on the other hand, mortality of shoots under B and D was far lower than the rest of the treatments.

(d) On yield.- Trash laid after germination tended to give slightly more yield than that laid at planting. D (sandwiched trash after germination) recorded the highest yield, followed by C and E. However the differences in yield were not significant.

(e) On juice-quality.- The various trash treatments did not appear to show any effect on juice-quality.

iii) Comparison of various kinds of agricultural wastes as mulching material.- To compare the utility of different kinds of mulching, an experiment with 7 treatments (vide Table 14) was conducted in 6 randomised blocks with a net plot size of 0.015 hectare using Co.S.510. The mulching treatments were applied in furrows after the completion of germination.

The results confirmed the tiller promoting effect of mulches in general; all the mulching treatments recorded higher shoot numbers than the control. The production of shoots was the highest under unchopped cane trash treatment (Table 14).

TABLE 14

Comparison of various kinds of mulching material

Cane planted	Treatment Trenches mulched with	Shoots in thousands per hectare	Millable canes in thousands per hectare	Yield in metric tons per hectare	Juice quality in December Pol per cent juice	Purity
A. in shallow trenches	Paddy husk	120.6	78.3	57.5	15.75	87.0
B. -do-	Chopped paddy straw	120.1	77.8	56.6	16.11	87.6
C. -do-	Cane trash	134.4	80.1	58.3	15.99	87.1
D. -do-	Chopped cane trash	119.6	83.5	59.1	16.93	88.3
E. -do-	Bhusa	112.2	76.4	53.5	16.31	87.1
F. -do-	Control (no mulch)	102.3	78.1	57.2	16.96	89.9
G. on flat	Control (no mulch)	128.5	80.6	52.1	16.49	88.7
LSD				3.4		

The differences in yield and juice quality among the various mulching treatments were narrow and non significant; planting in shallow trenches was superior to planting on flat.

4. Studies on cultural practices and cultural systems

i) Effect of different methods of planting on yield and quality of sugarcane.- Three methods of planting viz. i) on flat with seed-cane soaked in water for 2 hours, ii) in trench with seed-cane soaked in water for 2 hours and iii) in trench with unsoaked seed-cane but irrigated immediately after planting were compared in 5 randomised blocks with a net plot size of 0.011 hectare, using Co.997. The experiment was planted in the 1st week of March and repeated in April to see the efficiency of the methods under normal and late planting conditions respectively.

TABLE 15

Effect of methods of planting on yield and juice-quality of sugarcane

Method of planting	Cane yield in metric tons per hectare		Pol per cent juice in December	
	March-planted	April-planted	March-planted	April-planted
Flat with soaked seed-cane	51.42	47.44	12.44	11.71
Trench with soaked seed-cane	55.28	42.13	13.55	12.63
Trench with unsoaked seed-cane, followed by irrigation after planting	46.73	46.38	13.56	11.95
LSD at 5 per cent level	7.09	7.46		

The treatment differences were non-significant. It was interesting to note that the juice-quality was better in the trench-planted cane at both times of planting (Table 15).

ii) Intercropping opium-poppy with sugarcane.- The experiment was in its second year. The three treatments, viz. i) opium-poppy followed by sugarcane, ii) opium-poppy intersown in October planted sugarcane, and iii) October-planted sugarcane were compared in 8 randomised blocks with a net plot size of 0.012 hectare using Co.S.510.

Like last year, opium-poppy had to be sown twice as it failed to germinate at the first sowing.

On 21st March 1960 just when the crop had put forth capsules, there was a severe hailstorm which caused total damage to the poppy. Due to this the effect of intersowing opium-poppy on shoot number and later on cane

yield was not quite marked; the difference in yield of cane with opium-poppy intersown in sugar cane and sugarcane alone were narrow and non-significant. Juice-quality also did not show any appreciable difference.

The treatment of opium-poppy followed by sugarcane planted in April gave a significantly lower yield than the other treatments.

As reported last year, opium-poppy is a very sensitive crop and presents difficulties due to its uncertain germination. The experiment was carried out at the request of the Department of Central Excise, and has now been terminated.

5. Fertilisers and manures

i) Assessment of Complesal-Supra as a fertiliser for sugarcane.- To study the efficiency of a fertiliser called Complesal-Supra (14 per cent N and 14 per cent P_2O_5) for sugarcane in comparison with ammonium sulphate and urea alone and each of these in combination with superphosphate, an experiment was laid out in 5 randomised blocks with a net plot of 0.005 hectare, using Co.453. This was the 3rd year of the experiment.

TABLE 16

Response of 'Complesal-Supra' to sugarcane

Treatment			Cane yield in metric tons per hectare	Juice-quality in December	
Fertiliser	N kg. per hectare	P_2O_5 kg. per hectare		Pol per cent in juice	Purity
Complesal-Supra	89	89	96.3	9.6	71.6
Urea + Superphosphate	89	89	92.0	9.95	73.9
Ammonium sulphate + superphosphate	89	89	91.8	9.86	73.3
Urea	89	-	81.3	11.19	78.0
Ammonium sulphate	89	-	96.7	10.12	74.3
Control	-	-	86.8	10.65	75.4
LSD			13.94		

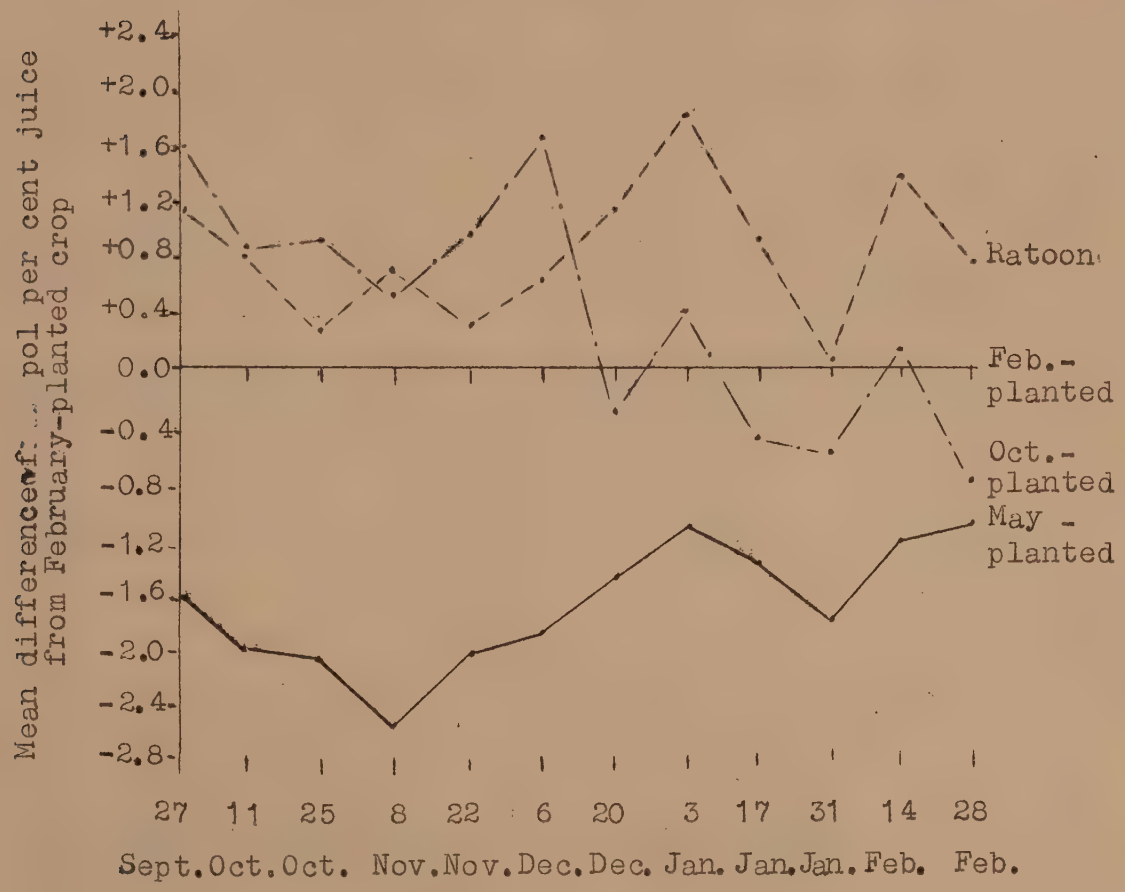
Complesal-Supra and ammonium sulphate alone gave equal yields, which were higher than the remaining treatments. Barring the treatment of 89 kg. nitrogen in urea, the differences in yield as between control and remaining treatments were not significant (Table 16).

In juice-quality Complesal-Supra recorded about 1.0 unit lower pol. per cent juice than the control.

6. Studies in ripening

i) Progress of ripening in sugarcane crops.- Data on the progress of ripening of Co.951 and Co.S.510 planted in October, February and May and also ratoons of these varieties were recorded from September to March. Cane samples each about 40 kg. were drawn from each crop and the juice analysed for brix, pol, purity and invert sugar. The differences in the trends of ripening are shown in fig.2.

Fig.2. Progress of ripening in sugarcane crops



(N.B. i. The above graph shows, not the actual progress of ripening of the ratoon, the October-planted and the May-planted crops, but the deviations of the pols per cent juice of these various crops from the standard February-planted crop, fortnight to fortnight. The ripening of the February-planted crop thus forms the base-line, and the deviations of the other crops are given as + or - from it. This clearly brings out the stages at which pol per cent juice of each crop supersedes or declines from that of the February-planted crop. N.B. ii. Since the trends of ripening of the different crops as against their respective February-planted crops were similar in the two varieties, Co.S.510 and Co.951, their data were averaged).

To start with, October-planted crops of both Co.951 and Co.S.510 gave slightly superior juice-quality to ratoon, February- and May-planted crops, and this position was retained by the October-planted crop up to November in Co.S.510 and up to December in Co.951. After this, the October-planted crop was superseded by the ratoon, which continued to give the best juice-quality up to March. The February-planted crop which had a poorer quality of juice than the October-planted crop in the beginning of the season surpassed it in February. The ratoon more or less maintained its superiority till early March. The May-planted crop of both the varieties gave the lowest juice-quality throughout.

Plant cane of Co.997 was added to the record from October onwards. The results on this variety followed more or less the same trends of intertreatment supersessions as Co.951 and Co.S.510. The differences between the February- and May-planted crops of this variety were narrow after November.

Needless to say, among the three varieties, Co.997 gave the best juice-quality, closely followed by Co.S.510, Co.951 being the poorest.

ii) Ripening of varieties in relation to time of planting.- To study the ripening performance of 6 varieties (Co.453, Co.527, Co.969, Co.997 and Co.1111) of fairly known characteristics, under October and February planting, a trial was laid out in a split-plot design with main plots to time of planting and subplots to varieties in 4 replications with a plot size of 0.007 hectare.

TABLE 17

Performance of varieties in relation to time of planting

Variety	Cane yield in metric tons per hectare		Pol per cent juice in			
			November		December	
	Autumn-planted	Spring-planted	Autumn-planted	Spring-planted	Autumn-planted	Spring-planted
Co.453	75.68	78.45	10.64	10.28	11.52	12.21
Co.527	76.23	78.23	8.24	6.79	11.22	9.98
Co.969	77.56	75.19	8.44	9.23	10.81	11.64
Co.976	82.05	82.63	11.19	11.50	14.51	13.66
Co.997	50.24	43.00	11.16	10.01	13.37	14.36
Co.1111	93.08	79.44	8.84	7.77	11.72	11.47
Mean	75.81	72.82	9.75	9.26	12.19	12.22

LSD at 5 per cent level varieties	7.88 metric tons
Time of planting	Not significant
Interaction	Not significant

As observed under experiment 6(i) the progress of ripening differed with the age of the crop; the longer the age the better the opening juice-quality. But with the

advance of season, the February-planted crop exhibited superior juice-quality to October-planted one.

Varieties also differed in their ripening capacity. Co.1111 showed a high rate of ripening from November to December followed by Co.997 and Co.527: the latter variety has given an exceptionally low juice-quality probably due to the increasing wilt infection in this variety. Co.453 showed the slowest rate of ripening.

In the matter of yield the varieties did not show interaction with the time of planting.

7. Varietal work

i) Seedlings.- A total of 9,831 seedlings comprising 13 crosses, some having Co.449 and others Co.S.109 as female parent, was received in 1960. As there was excessive dryage of seedlings in transit, many seedlings failed to survive the transplanting. Later in the hailstorm which occurred on 21st March 1960, most of the established seedlings perished. The 253 seedlings left were raised to maturity and from this batch on the basis of growth and cane type, 52 were selected. These had an average brix of 17.4. This is 2.8 units inferior to the average brix of last year's batch. The seedlings have however, been planted out for testing in a preliminary trial in the crop year 1961-62.

TABLE 18

Selections from the 1960-batch of seedlings

Cross	Number of seedlings at maturity	Number of seedlings selected	Per cent seedlings selected
Co.449 x Co.313	9	3	33.3
Co.449 x Co.453	5	1	20.0
Co.449 x Co.513	11	Nil	0
Co.449 x Co.589	3	Nil	0
Co.449 x Co.617	12	1	8.3
Co.449 x Co.758	20	4	20.0
Co.449 x Co.842	0	Nil	0
Co.449 x Co.846	1	Nil	0
Co.S.109 x Co.449	59	12	20.3
Co.S.109 x Co.453	62	9	14.5
Co.S.109 x Co.846	40	8	20.0
Co.S.109 x Co.859	9	5	55.5
Co.S.109 x Co.961	22	9	40.9
	253	52	17.8

It was observed that the survivals were generally more in crosses with Co.S.109 than with Co.449 as the female parent (Table 18).

ii) Preliminary test of seedling varieties 1959-batch.- 110 seedlings varieties were selected for further

TABLE 19

Yield, juice-quality and general characteristics of the 1961-batch of Co. canes selected at the Indian Institute of Sugarcane Research, Lucknow.

Co. number	Seedling number	Parentage (as intimated by the Coimbatore Institute)	Cane yield in metric tons per hectare	Juice-quality in December: Per cent in juice	December: Purity	January: Per cent in juice	January: Purity	Estimated outturn of sugar in metric tons per hectare	General characteristics
Co.1328	G.12061	Co.1118 x Co.1101	119.3	11.02	74.6	14.78	85.6	12.03	A medium-thick cane with fair yield and juice-quality.
Co.1344	G.10516	Co.508 x Co.453	94.4	12.93	77.6	16.23	87.3	10.85	A cane of medium thickness with good juice-quality; mid-season in ripening.
Co.1345	G.12159	C.P.36/111 x Co.945	121.1	12.08	74.8	15.43*	84.2*	12.63	A mid-season cane with satisfactory yield and quality.
Co.1346	G.12408	Co.775 x Co.419	97.2	13.54	82.8	12.61	82.4	8.18	Medium-thick canes; mid-early ripening.
Co.1347	G.11985	Co.453 x Co.798	95.8	14.09	84.5	15.40	86.8	10.13	An early maturing with fair yield.
Co.1348	P.11537	Co.449 x Co.801	125.3	11.56	74.6	14.75	85.3	12.45	A medium-thick cane, mid-season in ripening.
Co.1349	P.11996	Co.453 x P.8331	115.2	12.25	77.7	14.63	85.3	11.39	Medium-thick canes with good juice-quality.
Co.453	-	-	142.7	9.93	70.4	13.81	83.2	16.83	Standards
Co.S.510	-	-	144.6	14.79	89.2	14.82	84.9	15.05	

* February analysis

testing from the 1959-batch of seedlings received from Coimbatore and were planted for preliminary tests. On the basis of agricultural characteristics and juice-quality by the hand-refractometer, 30 varieties were selected for the final test. Of the selected varieties S.28, S.29, S.60 and S.79 were promising.

iii) Final test plot.- 84 varieties comprising 69 G-, and 15 P-seedlings were in the Final Test against the standards, Co.453 and Co.527. Based on the usual criteria including juice-quality in December and January, 4 G-seedlings and 3 P-seedlings were selected and raised to Co. status and given numbers Co.1328 and Co.1344 to Co.1349. Of these Co.1344 and Co.1347 are promising (Table 19).

About 10 kg. of seed-material of the above new Co. varieties was supplied to the Research Stations at Shahjahanpur, Gorakhpur, Patna, Pusa, Burdwan and Jorhat in the last week of February 1961.

An important outcome of the seedling raising and testing work at Lucknow for the north-eastern stations is that it is now possible i) to supply varieties selected under north Indian soil and climatic conditions, ii) to supply new selected varieties one year earlier, iii) to supply an adequate quantity of seed-material in each variety, and iv) to supply the material expeditiously. These advantages should enable a quick multiplication of the seed-material at the State Research Stations and help to improve the selection process in every way.

iv) Trial of varieties.- Eight varieties viz. N.Co.291, N.Co.351, C.P.29/320, Co.785, Co.1254, Co.1305, Co.1306 and Co.1308 were compared against the standards, Co.453 and Co.527 in 3 randomised blocks with a net plot size of 0.005 hectare (Table 20).

TABLE 20

Performance of varieties in varietal trial

Varieties	Cane yield in metric tons per hectare	November Pol per cent juice (purity)	December Pol per cent juice (purity)	January Pol per cent juice (purity)	February Pol per cent juice (purity)	Fibre per cent in Jan.	Sugar in metric tons per hectare
1	2	3	4	5	6	7	8
Varieties selected							
Co.785	58.53	13.09 (81.2)	15.67 (86.2)	15.05 (85.5)	17.24 (89.0)	14.7	7.49
Co.1254	81.00	11.09 (77.3)	12.74 (81.4)	14.80 (85.1)	13.56 (83.2)	15.9	7.68
Co.1305	69.51	12.19 (77.4)	13.18 (80.8)	14.61 (84.2)	17.28 (88.5)	11.8	9.22
Co.1306	71.96	13.56 (83.3)	14.23 (86.1)	15.83 (88.6)	16.64 (90.5)	13.8	9.07
Co.1308	66.15	11.53 (77.0)	12.89 (80.6)	13.84 (82.6)	16.01 (87.1)	12.4	7.98

1	2	3	4	5	6	7	8
			Varieties rejected				
N.Co.291	46.08	7.56 (65.9)	9.93 (72.8)	10.19 (74.5)	11.32 (78.3)	11.3	3.68
N.Co.351	54.76	10.40 (73.6)	12.71 (80.4)	14.77 (85.5)	15.67 (86.4)	12.1	6.45
C.P.29/320	37.71	14.71 (82.0)	14.69 (81.6)	15.07 (83.9)	16.45 (85.6)	14.7	4.50
			Standards				
Co.453	82.58	11.95 (77.4)	12.74 (80.5)	13.70 (82.9)	15.95 (86.4)	14.3	9.64
Co.527	65.73	11.13 (77.5)	11.32 (76.9)	13.80 (83.2)	15.89 (87.8)	12.8	7.88
LSD at 5 per cent level	14.38						

The following varieties were found to be very promising. Their suitability for cultivation and behaviour under different soil and climatic conditions can be decided only after they have been tested at various State research stations.

1. Co.1254 - A high yielding, mid-season variety with a fairly satisfactory stand and good stalks.

2. Co.1305 - A variety with a satisfactory yielding capacity and good juice-quality. It is moderately resistant to red rot.

3. Co.1306 - Has shown a high yield and high sugar content; the sugar outturn was 9.07 metric tons per hectare. Its field performance however is average and the canes are liable to lodge. The variety is also susceptible to red rot.

4. Co.1308 - This is a medium-thick variety with erect canes. It possesses high vigour. Its yield and juice-quality are satisfactory. It is moderately resistant to red rot.

5. Co.785 - This variety has given a very good opening juice-quality consistently with fair yielding ability. The foliage and condition of canes are satisfactory. The canes are vigorous, but somewhat slender and liable to lodge. The comparatively low yield is probably due to lodging. The variety already has a good record at Pamba in Kerala State and also in Madras State and in the light of its above performance at Lucknow, it appears to deserve further tests in States.

The three foreign varieties tried N.Co.291, N.Co.351 and C.P.29/320 were unsatisfactory both in yield and outturn of sugar per hectare. C.P.29/320 has an exceptionally good juice-quality in November, but is a low

yielding thin cane, highly susceptible to root rot: well-grown, healthy-looking clumps of it dried up completely within a matter of 3-4 days due to root rot.

v) Large-scale trial of promising varieties.-

A large-scale trial with 5 promising varieties viz. Co.975, Co.976, Co.1107, Co.1111 and Co.1158 and two standards, Co.453 and Co.527 was laid out in 6 randomised blocks with a net plot size of 0.015 hectare.

TABLE 21

Performance of varieties in large-scale trial of promising varieties

Variety	Cane yield in metric tons per hectare	November Pol per cent juice (purity)	December Pol per cent juice (purity)	February Pol per cent juice (purity)	March* Pol per cent juice (purity)	Fibre per cent in Feb.	Sugar in metric tons per hectare
Co.975	61.08	8.90 (68.7)	10.27 (72.6)	12.73 (80.1)	14.48 (83.0)	13.4	6.28
Co.976	80.46	13.32 (81.3)	13.43 (82.3)	14.53 (84.4)	17.54 (87.9)	14.7	10.53
Co.1107	73.27	8.20 (63.7)	11.45 (73.2)	12.31 (76.3)	11.19 (74.4)	11.1	5.46
Co.1111	77.10	9.01 (67.6)	11.04 (73.2)	11.30 (75.0)	14.38 (82.5)	16.4	8.18
Co.1158	73.04	10.31 (73.6)	12.57 (80.0)	14.45 (83.5)	16.87 (88.0)	13.7	9.24
		Standards					
Co.453	71.71	9.82 (71.9)	10.63 (74.5)	11.69 (77.7)	15.24 (85.4)	12.6	7.73
Co.527	77.71	9.62 (72.7)	10.12 (73.7)	12.17 (79.9)	15.00 (85.5)	12.2	8.70
LSD at 5 per cent level	13.94						

* Data of one replication.

As all the varieties were top-selections of the past few years, the differences in the cane yield between the varieties were, as expected, non-significant (Table 21). This trial and earlier observations have brought out the special features of the variety, Co.1158. This variety appears to be an all-round cane. It recorded a higher tonnage, better juice-quality, and a higher c.c.s. than Co.453.

Co.1158 does not grow very tall. But it is an erect variety with uniform, heavy, medium-thick canes, excellent stand, good foliage and very satisfactory juice-quality and sugar outturn. It is rated to be moderately resistant to red rot in the plug-inoculations carried out at this Institute. The most outstanding feature of this variety is that it does not ordinarily lodge.

Co.976 gave the best performance this year, but it showed susceptibility to wilt. Co.1111 which recorded top yields during the last two years came next to Co.976, probably because it lodged extensively and badly after its heavy growth. Due to this and its poor juice-quality it has now been rejected. Of the remaining varieties Co.975 has a low yielding capacity but its juice-quality is at par with the standards. Its low yield greatly affects its sugar outturn. Co.1107 is a medium-thick variety with satisfactory yield and juice-quality and showed moderate resistance to red rot.

vi) New arrivals.- 87 varieties comprising 8 Co. canes of the 1960-batch (Co.1309 to Co.1316 both inclusive), and 79 foreign varieties were received from the Sugarcane Breeding Institute, Coimbatore, during the year. The varieties are being multiplied for further testing.

vii) Despatch of canes.- Seed-cane of the 7 new Co. canes viz. Co.1328, Co.1344 to Co.1349 was despatched to the Sugarcane Research Stations at Shahjahanpur, Gorakhpur, Pusa, Patna, Burdwan, and Jorhat. About 10 metric tons of seed-cane of approved and promising varieties was supplied to factory farms.

viii) Live herbarium.- There were 517 varieties in the live-herbarium during the year.

8. Sugarbeet

Experimental work on the cultivation of sugarbeet in India was continued at the Institute and a system of coordinated trials in various parts of India was carried out with the collaboration of the State Sugarcane Research Stations. The reports of these trials are given separately in a separate sectional report.

Statistics

The designing of the experiments of the different sections of the Institute, their analysis and interpretation by appropriate statistical methods continued to be the major part of the work of this section.

General review of experimental precision.- Most of the sugarcane field experiments of the sections were conducted with the simple randomised blocks and split-plot layouts with 4 to 8 replications. In experiments on cane the plot size varied from 0.02 to 0.01 hectare in beet from 0.012 to 0.008 hactare. The data from the entomological experiments were analysed after using proper transformations. The above covers about 200 field experiments.

The coefficient of variation for cane yield for agronomy experiments varied from 8.9 to 13.2 per cent, for pol per cent 3.2 to 5.2 and fibre per cent from 2.9 to 3.0. For sugarbeet experiments the c.v. for yield of roots ranged between 7.8 and 11.9 per cent.

In the experiments of the Soil Science Section, the lowest c.v. was 12.3 and the highest 16.6. In the Entomology Section, where the most of the analysis had to be performed by applying $\sin^{-1}\sqrt{\text{per cent}}$ transformation, the minimum was 7.3 while maximum was 28.7.

The above review indicates that the experiments do not have a large natural variation. The coefficients of variation are within usual limits and the standard of experimentation at the Institute therefore appears to be satisfactory.

Germination analysis.- 385 healthy canes of Co.997 were each cut into single-budded setts and planted 30 cm. apart in the 3rd week of March, 1960. The germination data were scrutinised for finding out whether under uniform conditions, the number of germinated buds bears any relation to the total number of buds on the stalk. The problem arose from the differential germination in stalks which had been observed in another section. The application of 't' test on the $\sin^{-1}\sqrt{\text{per cent}}$ transformed values showed that there are no significant differences in the germination percentages of canes having different numbers of buds. Regression analysis on total germinated buds confirmed the conclusion.

Transformation study on small samples.- Last year it was established on a very large number of samples that the number of tillers in a clump obeys the law of negative binomial distribution. This year an attempt was made to analyse a set of data from a small sample by applying the appropriate transformation. The data were obtained from 8 clumps chosen at random from each of 5 rows from plots of 6 varieties Co.453, Co.975, Co.1058, Co.1062, Co.1096 and Co.1105 in one replication of the standard varietal trial 1958. The analyses of variance without and with transformations are given in table 22.

TABLE 22

Analyses of variance of number of tillers per clump in sugarcane varieties

Source	d.f.	S.S.	M.S.	F
1	2	3	4	5
1. Without transformation				
Between varieties	5	336.34	67.27	12.96**
Within varieties	24	219.70		
Residual	210	1090.13	5.19	
Total	239	1646.17		

1	2	3	4	5
2. With $\sinh^{-1}\sqrt{r}$ transformation				
Between varieties	5	8.36	1.67	7.66**
Within varieties	24	5.85		
Residual	210	45.81	0.22	
Total	239	60.02		
3. With $\sinh^{-1}\sqrt{(r+0.5)}$ transformation (Bartlett)				
Between varieties	5	4.28	0.86	9.07**
Within varieties	24	2.65		
Residual	210	19.82	0.09	
Total	239	26.75		

** Significant at 1 per cent level

It was found (Table 22) that the efficiency of the first transformation is 23.8 per cent and of the second 55.0 per cent showing that the two transformations have progressively improved the senstivity of the test. The differences which were not descernible by the usual analysis became apparent after the transformation.

Weekly change in sugar recovery per cent.- In a continuation of the study on the weekly recovery figures of sugar factories in the various tracts of the Indian Union for finding out the probable crushing period for each tract in which the recovery may be expected to remain higher than a desired figure, and to represent the recovery change by an algebraic curve, orthogonal polynomials were fitted to the data.

TABLE 23

The degree of the polynomial and its constants fitted to the weekly sugar recoveries of the Indian Union 1960-61

Tract	Degree of Polynomial	Constant	First degree	Second degree	Third degree
Punjab	Linear	8.5874	0.0872		
West U.P.	Quadratic	9.2306	0.1359	-0.0045	
East U.P.	Quadratic	9.4322	0.2153	-0.0129	
North Bihar	Quadratic	9.2386	0.1983	-0.0141	
South Bihar	Quadratic	8.7870	0.2895	-0.0243	
West Bengal	Cubic	9.7682	-0.0194	+0.0480	-0.0044
Assam	Quadratic	5.9395	0.6629	-0.0399	
Madhya Pradesh	Quadratic	8.4619	0.4042	-0.0270	
Gujrat	Quadratic	10.9177	0.2602	-0.0216	
Maharashtra	Quadratic	11.5183	0.3511	-0.0267	
Mysore	Cubic	11.2136	-0.2522	+0.0774	-0.0058
Andhra Pradesh	Quadratic	8.9259	0.3893	-0.0267	
Pondichery	Cubic	7.2426	-0.0134	+0.0556	-0.0039
Madras	Linear	9.3041	0.0486		

The values of the different polynomial constants (Table 23) show that recovery curve for Punjab and Madras is linear, for West Bengal, Mysore and Pondichery cubic and for the rest of the tracts quadratic. Where the curve is cubic, recovery rises slowly to reach the peak and then falls sharply. Obviously, in these cases if the crushing period is to be extended, it should start earlier, but terminate soon after the highest recovery is reached. In the areas of the quadratic curve, the rise and fall of recovery are more or less similar and therefore the crushing period can extend equally on both the sides of the peak date.

Refresher course in statistics.- The statistical assistant delivered four lectures to the technical staff of the Institute on statistical methods. Two booklets 'Example of Statistical Analysis of a Randomised Block design Experiment' and 'Regression and Correlation' were prepared and distributed among the technical staff of the Institute for their reference.

1. Modus operandi of green manure

The objective of this experiment is to study functions, behaviour and reactions associated with the practice of green manuring in tropics (vide last year's report) The experiment was laid out in a 5 x 5 Latin square design with treatments as shown in table 24. Apart from outturns of cane and quality of juice, certain soil properties were determined in the respective treatments.

TABLE 24

Yield of cane, juice-quality and some properties in the *modus operandi* of green manure experiment

Treatments	Yield of cane quintals per hectare	No. of millable canes per hectare	Juice-quality: Pol per cent juice	Juice-quality: Purity	Nitrogen per cent in leaf	Total nitrogen per cent soil after harvest of cane	Organic carbon in soil after harvest of cane
1. Control	487	66,920	18.6	90.8	0.98	.057	.364
2. *Sanai* grown and buried	735	81,495	18.0	89.2	1.27	.060	.374
3. *Sanai* grown and burnt *in situ*.	684	73,860	17.9	88.0	1.26	.058	.378
4. Ammonium sulphate 67 kg. N perhectare	704	77,464	17.8	90.5	1.30	.058	.364
5. Farm yard manure	453	69,175	18.0	89.8	1.14	.053	.367
LSD	104	Not-significant					

An examination of the yield data reveals that there is no response of cane to farmyard manure. However, very good responses to *sanai* green manure, *sanai* burnt *in situ* and to application of ammonium sulphate have been obtained. The fact that the treatment in which the green manure crop was burnt has given as high yield/increase as the green manured plots suggests that the operation of green manure is not mainly through organic matter and nitrogen of the above-ground parts, because both of them were lost in the process of burning. It could be postulated here that the effect of green manure is mainly through the retention and mobilization of nutrients other than nitrogen. The nutrient effect of decomposing organic matter is manifested only after decomposition. Burning achieves the same objective very quickly. Burning of the tops is as effective as the application of nitrogen at the rate of 67 kg. per hectare as ammonium sulphate. This fact is elucidated by data on yield and nitrogen uptake. The fact that in the treatment in which tops were burnt, sugarcane leaves show the same nitrogen percentage suggests the possibility of increased *Azotobactor* and *Clostrium* activity in this treatment because of desirable source of energy (slow decompo-

sition of roots) and suitable mineral salt medium. However, this is a hypothesis and is being tested in laboratory by simulating field conditions.

The soil data indicate there is no residual effect of green manure in terms of organic carbon.

This experiment will be repeated for four years in the same field in order to ascertain the long term effects of green manuring on the soil in respect of improvement in soil structure and moisture relationship of soil.

2. Aqua ammonia as a source of nitrogen

This was the second year of the experiment. Unlike last year, during the year under report only ammonium sulphate and aqua ammonia were compared at the rate of 67 kg. nitrogen per hectare.

TABLE 25

Effect of aqua ammonia and ammonium sulphate on the yield and juice-quality of sugarcane

Treatments	Yield of cane in quintals per hectare	Juice-quality	
		Pol per cent juice	Purity
1. Control	478	17.2	89.6
2. Ammonium sulphate at the rate of 67 kg. N per hectare	468	16.8	88.7
3. Aqua ammonia at the rate of 67 kg. N per hectare	533	16.3	87.8
LSD	Not-significant	Not-significant	Not-significant

Aqua ammonia has given a yield of 533 quintals per hectare as against 478 in the control. The increase in yield is accompanied by usual expected depression in juice-quality. However, ammonium sulphate has failed to show any response.

Two years data show that aqua ammonia can be used as a fertiliser and can be expected to yield about 0.82 quintals of cane per kg. of nitrogen.

3. Potassium fertilisation of sugarcane

This was the third year of the experiment.

TABLE 26

Effect of potassium on the yield and juice-quality of the sugarcane crop

Treatment kg. K_2O per hectare as K_2SO_4	Weight of cane in quintals per hectare	Number of millable cane per hectare	Juice-quality	
			Pol per cent juice	Purity per cent
0	602	81,345	16.1	85.7
28	615	86,798	15.5	84.1
56	618	86,485	15.9	86.4
84	682	89,782	16.0	86.5
112	631	82,135	15.9	86.6
168	597	84,244	15.6	85.1
	Not-significant	Not-significant	Not-significant	

Although all the potassium-treated plots except 168 kg. K_2O per hectare plot have yielded more than control, the treatment differences are not statistically significant. Similarly the juice-quality has not been affected by applications of potash.

An examination of data collected on the amount of exchangeable potassium and the release of potassium from 'fixed' and mineral potassium (vide last year's report) suggests that the soils of the Institute's farm have adequate supplies of exchangeable and water soluble potassium. The rate of renewal is also adequate, therefore, they are not likely to respond to potassium application. The experiment is concluded during this year.

4. Phosphorus fertilisation of sugarcane

A field experiment was conducted to investigate whether there is any response of sugarcane crop to phosphorus placed as double band on both sides of the setts at a depth of 7.5 and at a distance of 15 cm. Superphosphate was applied at the rate of 0, 56, 112, 168, 224, 336 kg. per hectare over a basal dose of 135 kg. of nitrogen as ammonium sulphate. The main objective of the experiment is to investigate why even high dose of phosphorus placed at a convenient place for roots to utilise, is not taken up by sugarcane. The uptake of phosphorus and the yield and juice-quality of the crop data are reported in table 27. Data on the soil phosphorus and its behaviour have not been completed yet and will be given later.

TABLE 27

Effect of application* of superphosphate at different doses on the yield, phosphorus uptake and juice-quality of cane crop (Co.510)

Treatment kg. P_2O_5 per hectare as superphosphate	Weight of cane in quintals per hectare	Number of millable canes per hectare	Phosphorus per cent in sheath	Juice-quality	
				Pol per cent juice	Purity
1	2	3	4	5	6
0	608	81,243	0.16	85.6	15.2

1	2	3	4	5	6
56	578	81,340	0.19	15.0	81.6
112	609	80,386	0.18	15.4	86.1
168	621	85,899	0.19	14.1	81.9
224	675	82,199	0.19	15.2	83.8
336	612	80,742	0.18	15.5	88.3
	Not-significant	Not-significant	Not-significant	Not-significant	

* The 50 kg. dose was placed in single band. All the higher doses of superphosphate were placed as a double-band. There was no effect of phosphorus on the yield and juice-quality of sugarcane. There was very slight uptake of phosphorus. Experiments are in progress to assess and evaluate soil and plant factors which rendered phosphorus ineffective and how to manipulate them so as to make the plant respond to phosphorus applications.

5. Leaf yellowing in sugarcane

In July 1960, in field D34 of the Institute Farm, a certain type of chlorosis of sugarcane leaves was noticed in variety Co.527. This chlorosis was characterised by a bleaching of leaf tissues between the vascular bundles, resulting in well-defined pale yellowish-green to whitish longitudinal stripes alternating with stripes of the normal green colour. The progress of the affection was quite rapid, culminating in the chlorotic stripes becoming almost white. From the symptoms it appeared that it might be a case of manganese deficiency. By Nicholase's rapid chemical tissue test for determination of mineral status of the plant in the field the chlorosis was tentatively diagnosed as a case of manganese deficiency.

Samples of healthy and diseased plants of the same age were collected for chemical analysis. After washing with distilled water, each sample was divided into (1) leaf blade, (2) leaf-sheath, (3) elongating cane internodes and (4) spindle cluster. These samples were carefully dried and manganese was determined colorimetrically by periodate method. The analytical results are given in table 28.

TABLE 28

Manganese content of different tissues of healthy and affected cane

Tissues	Manganese content of healthy and diseased cane in ppm.	
	Healthy cane	Diseased cane
1. Leaf blades	125	35
2. Leaf-sheaths	140	40
3. Elongating internodes	160	53
4. Spindle cluster	83	35

It was evident from the data that the manganese concentration in all the diseased samples was considerably lower than that of healthy samples.

A small field experiment with three treatments was conducted to study the effect of spraying manganese sulphate on the affected leaves. The treatments were i) spraying with water, ii) spraying with 125 ppm. Mn solution and iii) spraying with 250 ppm. Mn solution. Number of plants showing symptoms before and after spraying were counted (Table 29).

TABLE 29

Effect of manganese sulphate spraying on the recovery of chlorotic leaves

Treatment Spraying foliage with	Percentage of plants showing symptoms	
	before the treatment	after the treatment
i) water		26
ii) solution of manganese sulphate 125 ppm.	28 to 35	12
iii) solution of manganese sulphate 250 ppm.	35	10

The data show that spraying of manganese sulphate solution resulted in a reduction in the number of plants showing symptoms by over 50 per cent. The higher concentration did not produce a substantial further improvement over the lower concentration of the solution.

Healthy and affected canes were analysed for juice-quality in December 1960.

TABLE 30

Juice-quality of healthy cane and cane showing leaf-yellowing (Co.527)

Treatment	Pol per cent juice	Purity per cent	Invert sugar
1. Healthy cane	13.6	82.3	1.26
2. Cane showing leaf-yellowing	11.4	77.9	1.33

Data presented in table 30 show that the sucrose and purity of juice are adversely affected by the leaf-yellowing. Juice analysis of cane from manganese treated and control plots was done to see if spraying has any effect on the quality of cane (Table 31).

TABLE 31

Effect of spraying with Mn on the juice-quality of Mn deficient cane

Cane taken from	Brix	Pol per cent juice	Purity per cent
Control plots	16.1	12.92	80.4
Manganese sprayed plots	17.2	13.88	80.9

The data show that spraying of manganese improved the brix and pol per cent juice of the cane.

As the plots were small in size and most of the canes were taken away for juice analysis no yield data could be taken at the time of harvest.

Regarding the cause of manganese deficiency in the soil, all the experiments taken up could not be completed during the period under report. But data so far gathered have indicated that the possible cause of the deficiency is imperfect drainage and high free calcium and magnesium content of the soil. This condition causes overliming in some spots. The manganese deficiency is produced in the patches which fluctuate between a well-drained and a water-logged condition over the period of a year. Waterlogging during the monsoon period and subsequent withdrawal of the water removes the manganous manganese. After the withdrawal of excess water, conditions for rapid oxidation of manganese rapidly set in and cause a deficiency.

6. Studies on the colour of gur

Some preliminary studies were carried out on the development of colour in gur. On the basis of present day knowledge of colouring matter in fresh cane juice and its subsequent products, three sources for development of colour in gur cane be traced, namely (i) cane, (ii) iron crushers and boiling pans and (iii) the processing of juice for gur making. The effect of first two factors was studied during the period under report.

Cane stalks of three varieties Co.S.510, Co.951 and Co.975 were crushed (a) in a bullock-driven iron crusher and (b) in a brass-crusher. The juice in both cases was collected in glass beakers, divided each into 2 lots and boiled, one lot in a cast-iron pan and the other in an aluminium pan, both on kerosene oil stoves; gur was made in the usual way, with proper checks on the rate of boiling and striking point.

In a separate experiment two lots of cane of the same variety were crushed in a bullock-driven crusher: one lot was crushed in the normal way; in the other, the canes were fed encased in polyethylene tubes, so that contact with iron may be avoided. The juice samples were then boiled in an aluminium pan.

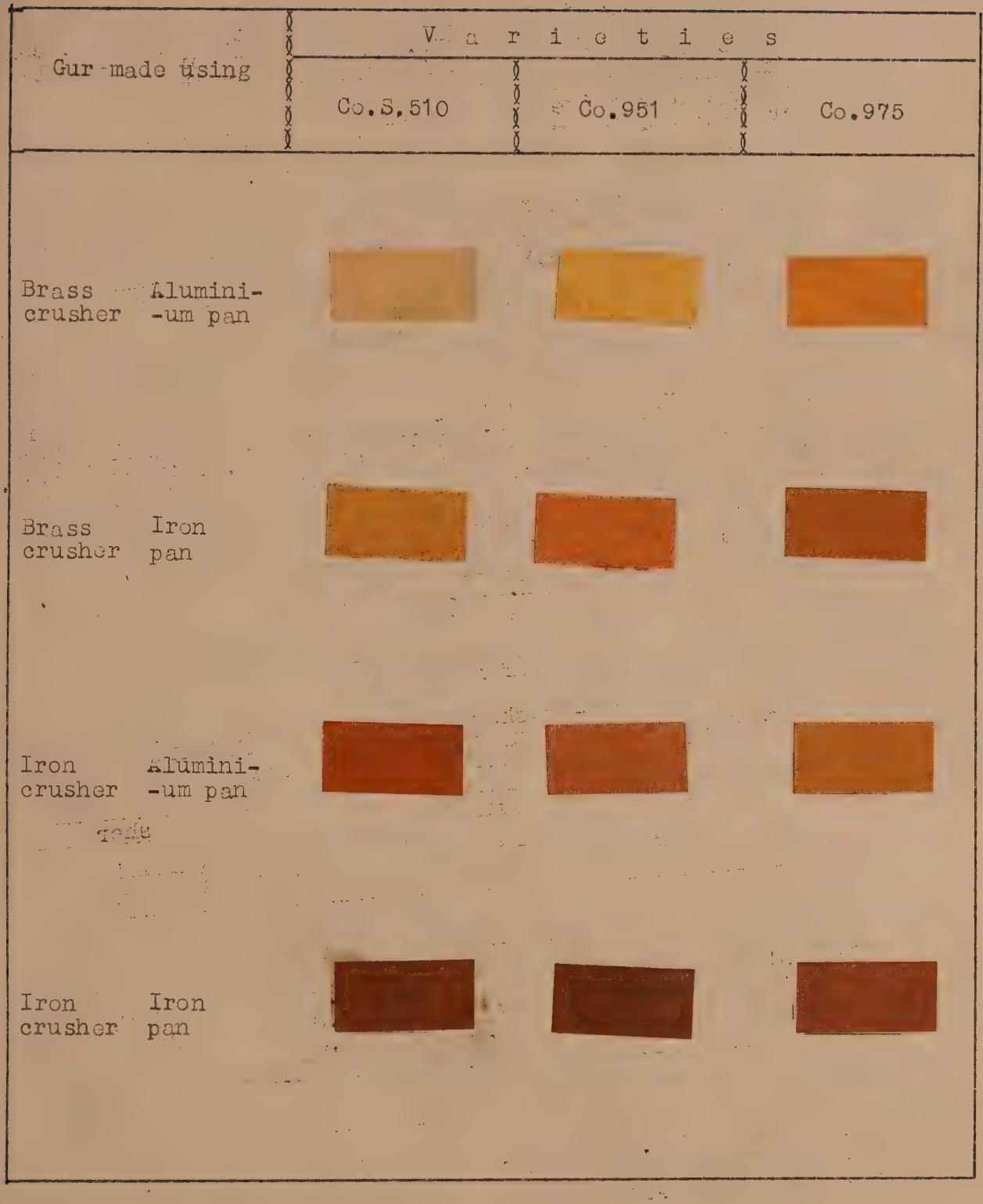


Plate 1. Effect of crusher and boiling pan on the colour of gur.

Striking differences were obtained in the colour of gur by these treatments. The colours of the samples are shown in plate 1. While the iron-crusher iron pan gur was quite dark, the brass-crusher aluminium pan gur was of a very attractive cream or cream brown colour. The iron crusher aluminium pan gur was intermediate, while the brass crusher iron pan gur was rust-coloured.

Gur prepared from the cane encased in a polyethylene tube while being crushed, and then boiled in an aluminium pan was also light coloured, but had a distinct greenish tinge. This is evidently due to more chlorophyll extracted with the juice as a result of heavier pressure exerted by the iron crusher. The dark colour developing in the iron-crusher-iron pan gur masked this tinge.

As expected, there were differences in the gur colour due to varieties. Co.975 gave, on the whole, light coloured gur while those of Co.951 and Co.S.510 were dark. There were also interactions, the colouring effect of iron being more in varieties which even without contact with iron yielded darker coloured gur.

The colour of the respective gur solutions (0.5N) were recorded from a K.S. Colorimeter using a 540 μ filter, adjusted to distilled water reading 0.

TABLE 32

Effect of iron-crusher and iron boiling pan on the colour of gur

Variety	Iron crusher		Brass crusher	
	Iron pan	Aluminium pan	Iron pan	Aluminium pan
	Unfiltered solution			
Co.S.510	657.5	581.0	435.0	407.5
Co.951	655.0	467.5	406.0	265.5
Co.975	374.0	239.5	196.0	133.0
	Filtered solution			
Co.S.510	373.5	292.5	207.0	100.5
Co.951	345.0	262.0	324.5	116.5
Co.975	119.0	95.0	79.0	69.0

The data in table 32 bring out the differences clearly. By eliminating contact of juice with iron, the colour of gur is markedly reduced in all the three varieties. It is obvious from the data that the colour effect is a sum total of the effects and interactions of factors at several stages. In the first stage the colour of juice is primarily conditioned by the composition of the cane itself in respect of anthocyanins, chlorophylls and tannins. Light coloured cane usually give light coloured juices, but even here there are potential differences due to the pre-

sence of substances which initially light coloured may give rise to colour in later reactions. Over this, in the second stage the pressure exerted on the rind by the crusher also influences the colour of juice and thereby the additions interactions. In the third stage the iron-crusher causes an increase in colour and this is heightened in the fourth stage when these and/or other substances come in contact with iron at a high temperature during the boiling.

The best result can obviously come from a combination of a minimum of these factors. The effect of other factors such as clarification and caramelization are additional but it appears from observation that these are less important. Further investigations are under way.

7. Unproductive soil patches at the Indian Institute of Sugarcane Research Farm

Many unproductive soil patches are found in different fields of the Institute farm especially in D block. Fertility of some of these patches is very low. An attempt was made to study the nature of these patches. Two types of such patches were diagnosed at the farm. One type of unproductive spots appears to be caused by the exposure of the sub-soil either in a levelling operation or as a result of erosion. In such spots the organic matter content of the soil is very low. The volume weight of the soil has increased, indicating that porosity is reduced, leading to poor moisture and air relationships. Such patches have generally low nutrient content, especially nitrogen. Analytical results of some patches from field D39 are given in table 33.

TABLE 33

Partial analytical data of soil samples from field D39

Sample taken from	pH.	Conductivity Mho/cm.	Bulk density	Total nitrogen per cent	Organic carbon
Bad patch (0-25 cm.)	7.5	1.90×10^{3}	1.76	.021	0.198
Good patch (0-25 cm.)	7.3	1.90×10^{3}	1.25	.064	0.654

In these patches, the root-spread is restricted to the surface. Very few roots penetrate the compacted soil and sub-soil. The combined effect of high bulk-density and the low nutrient content results in poor crop on such patches. Immediate improvement can be obtained by the incorporation of large quantity of farmyard manure and additional doses of nitrogenous fertiliser. Sub-soiling when the soil is dry will also help in lessening the compaction of the soil.

The other type of patches found in E and F blocks of the farm are "slick spots". They are small areas in otherwise productive fields and produce little or no crop growth. These alkali soil spots, having pH of 8.0 - 9.8 or even more all through the profile. They require essentially the same treatments as alkali soils do. Since these are small spots treatment with soil amendments like gypsum or sulphur or turning under a large quantity of organic matter will be better than providing cultural treatments like leaching, etc. because this would disrupt other field operations; however, they require heavier irrigation. Such spots are underlain by dense plastic horizons which seriously impede leaching operation. Reclamation will be quite slow and it will take several years to secure homogeneous fields.

8. Effect of soil compaction on the germination of sugarcane

The micro-experiment reported in last year was repeated. The data are given in table 34.

TABLE 34

Effect of soil compaction on the speed of the emergence of shoots from planted sugarcane setts (Number of buds germinated out of 24 planted)

Days after planting	Soil surface open			Soil surface mulched with chopped trash		
	Loose	Partially compact	Compact	Loose	Partially compact	Compact
11	1	0	0	0	0	0
12	2	1	0	0	0	0
13	2	3	0	0	0	0
14	4	4	0	1	2	0
15	5	6	1	3	4	1
16	7	9	3	4	5	1
17	9	10	6	6	7	2
18	10	10	7	8	8	3
19	13	11	7	9	10	4
20	13	12	9	10	12	7
22	15	14	11	10	14	8
23	15	14	12	12	15	9
24	16	15	14	14	16	11
25	16	15	14	14	16	11
26	16	16	16	14	16	12
27	17	16	16	15	16	12
28	17	16	17	15	17	14
29	17	16	17	15	17	15
30	17	16	18	15	18	15
35	18	19	21	16	19	16
Soil Temp. °C	34.3°	36.8°	38.0°	31.0°	31.0°	32.5°
	36.4°			31.5°		

Thirty-five days after planting 66 per cent germination was obtained in all treatments. The speed of germination was best in partially compacted soil, which however was only slightly better than loose soil. In compacted soil, sprouts definitely took more time to emerge, but the total number of germinated buds was not lower than in the loose condition. This supports last year's conclusion that compaction per se does not cause failure of germination of buds. Last year 39 days after planting only 5 per cent germination was obtained in the open, compacted soil whereas this year 88 per cent germination has been obtained. This large difference is due to differential moisture under this treatment during two years. While last year, the soil dried up rapidly in this treatment, this year, there was a rain of 15 mm. when the experiment was in progress, and the weather was cloudy. Since under such conditions evaporation was markedly less, moisture was not a limiting factor.

The total number of buds germinated as also the speed of germination were slightly less in mulched soil. This is presumably due to the lower temperatures of the mulched soil. If moisture is not a limiting factor, higher soil temperature induces better germination.

Thus taking both years data into consideration it could be safely inferred that while moderate packing of the soil is best, compaction of soil per se may not have a marked effect on the germination of buds, but it reduces germination by causing higher rate of evaporation and thereby a moisture deficit for the germinating bud.

9. Physiological, ecological and biochemical studies on Rhizobium spp.

Experiments were conducted to study the capacity of Rhizobium strains for utilising different energy sources. The strains isolated from gram, pea, sanai and dhaincha (vide last year's report) were used. The energy sources glycerol, arabinose, manitol, glucose, galactose, sucrose, dextrine and inulin were incorporated into nutrient agar media.

Manitol, glycerol, glucose and sucrose were found to be excellent sources for the growth of these strains. Galactose and arabinose were less effective than the above sources. Two strains of pea (PRh_3 and PRh_6) and one strain each of gram (GRh_6), (SRh_2) and dhaincha (DRh_1) showed poor growth with arabinase.

Dextrine and inulin have been found to be good for luxuriant growth of all the strains with only one striking difference that the medium turned alkaline whereas in all other cases, acid production was predominant.

10. Effect of gamma BHC on soil microbes

Gamma BHC is applied to sugarcane soils in 0.5 ppm. dose (one lb. of gamma BHC per 2,000,000 lb. of soil, which is the weight of 0-15 cm. surface soil) for the control of shoot borers and termites. Laboratory experiments were conducted to study the effect of this insecticide at

various rates of application on soil microbial population.

TABLE 35

Effect of gamma BHC on total bacteria and *Azotobacter* in soil

	Concentration of gamma BHC in ppm. in soil				
	0.0	0.5	1.0	2.0	5.0
Total bacterial population per gram of soil x 10^6	5.6	2.4	1.5	1.0	0.7
Azotobacter population per gram of soil x 10^6	0.95	0.45	0.20	0.05	0.00

The data indicate that there is a steep fall in the number of total bacteria and *Azotobacter* as a result of the application of gamma BHC. At the rate of 0.5 ppm., the fall is over 60 per cent in the total bacterial population in the soil and at 5 ppm. *Azotobacter* practically ceases to exist. The contention of some workers that gamma BHC stimulates the activity of soil bacteria and thereby promotes better nitrogen nutrition of cane crop does not seem to be borne out.

In another experiment, the effect of gamma BHC was studied on the vegetative growth of *Azotobacter vinalandii* on agar surface. The results of this experiment corroborate the observation made above (Table 36).

TABLE 36

Effect of gamma BHC on the vegetative growth of *Azotobacter*

Dose of gamma BHC in ppm.	0.0	0.5	1.0	1.5	2.0	5.0
Growth of *A. vinalandii*	Excellent growth	Moderate growth	No growth		No growth	

PHYSIOLOGY

1. Studies on nitrogen nutrition

The experiments on the basis of Clements's crop-logging system for assessing the optimum nitrogen index and phosphorus index were continued for the second year.

The experiment on nitrogen nutrition was laid out with Co.S.510 with six dosages of ammonium sulphate in 5 randomised blocks. In the treated plots, the fertiliser was applied in equal doses, at planting, in May and in July respectively. For the assessment of the nitrogen index of the crop, samples were drawn from middle six-inch portions of elongating leaves (3rd, 4th, 5th and 6th leaves from the top); for the moisture index elongating leaf-sheaths were collected. The samples were drawn at four-week intervals beginning from May.

TABLE 37

Total nitrogen per cent dry weight of 3rd, 4th 5th and 6th leaves of cane fertilised with different doses of ammonium sulphate

Period	N per hectare as ammonium sulphate						LSD at 5 per cent level
	0 kg.	68 kg.	136 kg.	204 kg.	272 kg.	340 kg.	
May 1960	1.68	1.81	1.91	1.98	2.03	2.06	0.07
June "	1.73	1.87	1.95	2.04	2.08	2.15	0.06
July "	1.33	1.62	1.77	1.95	2.02	1.88	0.14
August "	1.34	1.76	2.01	2.07	2.13	2.23	0.21
September "	1.27	1.74	2.00	2.01	2.02	2.03	0.12
October "	1.23	1.57	1.59	1.81	1.99	2.20	0.17
November "	1.18	1.50	1.55	1.70	1.70	1.76	0.10
December "	1.15	1.33	1.49	1.55	1.55	1.53	0.11

TABLE 38

Moisture per cent green weight of 3rd, 4th, 5th and 6th leaf-sheaths of cane fertilised with different doses of ammonium sulphate

Period*	N per hectare as ammonium sulphate						LSD at 5 per cent level
	0 kg.	68 kg.	136 kg.	204 kg.	272 kg.	340 kg.	
May 1960	71.5	72.8	74.0	73.4	73.0	72.4	-
July "	75.8	77.0	79.3	79.7	79.8	80.0	2.0
August "	79.1	80.2	81.8	82.2	82.8	82.7	0.9
September "	75.4	75.7	77.2	77.4	78.7	78.5	0.5
October "	71.5	72.8	73.6	73.9	74.3	74.5	1.2
November "	73.3	74.8	75.7	75.6	76.2	76.8	0.6
December "	69.4	71.3	71.0	70.6	71.5	71.5	1.5

* Leaf-sheath samples collected in June were attacked by fungus due to oven failure. Hence, they were not analysed.

TABLE 39

Yield and juice-quality of cane fertilised with different doses of ammonium sulphate

	N per hectare as ammonium sulphate						LSD at 5 per cent level
	0 kg.	68 kg.	136 kg.	204 kg.	272 kg.	340 kg.	
Yield of cane in quintals per hectare	384.1	531.7	572.9	589.6	559.6	575.8	30.9
Yield of sugar in quintals per hectare	37.6	51.6	51.7	53.7	49.7	48.0	5.6
Brix	18.0	18.1	17.2	16.9	16.6	16.1	0.8
Pol per cent juice	15.63	15.29	13.77	14.06	13.39	13.52	0.87
Purity	86.8	84.6	80.3	83.2	80.5	81.5	-

The data in tables 37 and 38 indicate that the nitrogen index and moisture index were significantly higher in the fertilised plots than in the control plots. In general, the nitrogen index was high in the fertilised plots upto September; thereafter, it showed a tendency to decline; whereas in the control plots, this fall in the nitrogen index was observed from July itself.

Considering the data on cane yield and nitrogen index of the crop from October to December in the experiments of both the years (1959-60 and 1960-61), it is observed that maintenance of a high nitrogen index in this period did not increase the cane yield. The relationship observed between the cane yield and the nitrogen index of the crop upto September indicates that an adequate nitrogen index should be maintained in the crop upto September. The optimum nitrogen index appeared to be in the range of 1.62 to 1.87, which is observed in the plots where 68 kg. of nitrogen per hectare was applied. While the maintenance of nitrogen index at a lower level is found to affect the cane yield adversely, when the nitrogen index is higher, i.e. 1.91 to 2.23 the output of sugar per hectare fails to be increased.

2. Studies on phosphorus nutrition

The experiment was laid out with Co.S.510 in 4 randomised blocks with 10 treatments. The four levels of phosphorus used for the determination of phosphorus index were 0 kg., 113 kg., 227 kg. and 340 kg. P_2O_5 per hectare, applied as superphosphate. Ammonium sulphate was applied uniformly at 113 kg. nitrogen per hectare.

For assessing the phosphorus index and moisture index of the crop, leaf-sheaths of 3rd, 4th, 5th and 6th leaves from the top were collected at four-week intervals beginning with May.

TABLE 40

Total phosphorus per cent dry weight of 3rd, 4th, 5th and 6th leaf-sheaths of cane fertilised with different doses of superphosphate

Period*	P_2O_5 per hectare as superphosphate				LSD at 5 per cent level
	0 kg.	113 kg.	227 kg.	340 kg.	
May 1960	0.142	0.167	0.161	0.153	-
July "	0.137	0.151	0.168	0.154	-
August "	0.170	0.168	0.163	0.168	-
September "	0.164	0.126	0.137	0.144	-
October "	0.143	0.148	0.146	0.162	-
November "	0.130	0.132	0.140	0.153	-
December "	0.136	0.175	0.170	0.185	0.027
January 1961	0.139	0.184	0.159	0.167	0.018

TABLE 41

Moisture per cent green weight of 3rd, 4th, 5th and 6th leaf-sheaths of cane fertilised with different doses of superphosphate

Period*	P_2O_5 per hectare as superphosphate				LSD at 5 per cent level
	0 kg.	113 kg.	227 kg.	340 kg.	
May 1960	78.5	78.5	78.2	77.1	0.9
July "	79.0	80.1	79.3	79.9	-
August "	81.3	80.9	80.3	80.5	-
September "	77.7	79.3	79.5	79.4	1.0
October "	77.8	79.2	79.8	79.5	0.9
November "	72.5	73.7	74.2	75.0	1.7
December "	68.9	71.7	70.6	70.8	-
January 1961	73.1	74.0	74.7	74.5	-

* Leaf-sheath samples collected in June were attacked by fungus due to oven failure. Hence, they were not analysed.

TABLE 42

Yield and juice-quality of cane fertilised with different doses of superphosphate

	P_2O_5 per hectare as superphosphate			
	0 kg.	113 kg.	227 kg.	340 kg.
Yield of cane in quintals per hectare	608.5	589.2	609.4	675.4
Yield of sugar in quintals per hectare	57.1	54.9	55.6	62.2
Brix	17.7	17.3	17.6	17.7
Pol per cent juice	14.98	14.22	14.92	14.85
Purity	84.6	83.3	84.5	83.6

There was no increase in the phosphorus index accountable to phosphorus fertilisation of the treated plots upto November; in December and January the phosphorus index was higher in the treated plots than in the control plots.

The level of phosphorus in the index tissue ranged from 0.126 to 0.185. Within this range of phosphorus index, the yield of the crop was not affected. The critical level, therefore, could not be ascertained.

3. Biochemical basis of resistance to red rot (In collaboration with the Mycology Section)

The experiment on the utilisation of various nitrogenous compounds from synthetic media by strains D and I of red rot was repeated this year.

The chromatographic analysis of the cultural filtrates of the strains, D and I confirmed the earlier results that the strain I differs from strain D in accumulating two ninhydrin - reacting substances (having Rf values lower than asparagine) in its culture media. These substances were not observed in the culture media of the strain D. The amino-acids observed in the culture media of both the strains are alanine, glutamic acid, glycine + serine and leucine.

4. Studies on prevention of flowering

Since the switch-over of the apical meristem from the vegetative to the reproductive phase is the result of the perception of the photoperiodic stimulus by the foliar organs and the consequent hormonal changes in the plant, one of the possible ways of preventing flowering is the elimination of the foliar organs most likely to perceive the photoperiodic stimulus during the critical photoperiod. Experiments were therefore conducted with

Co.1207 and Co.1062 with a view to determining the critical period and the minimal defoliation required for a total suppression of flowering.

The experiment with Co.1207 was laid out in 7 randomised blocks and the stalks were defoliated to two levels on different days at intervals of about 6 days in September, in Co.1062 the experiment was laid out in 8 randomised blocks and the stalks were defoliated to only one level at 6 day intervals starting from end-August to early-October. The two levels of defoliation were (A) removal of the spindle cluster (including the top-most dewlap blade) and (B) removal of the spindle cluster including the top-most dewlap blade and three more blades below it, against (C) an undefoliated control.

TABLE 43

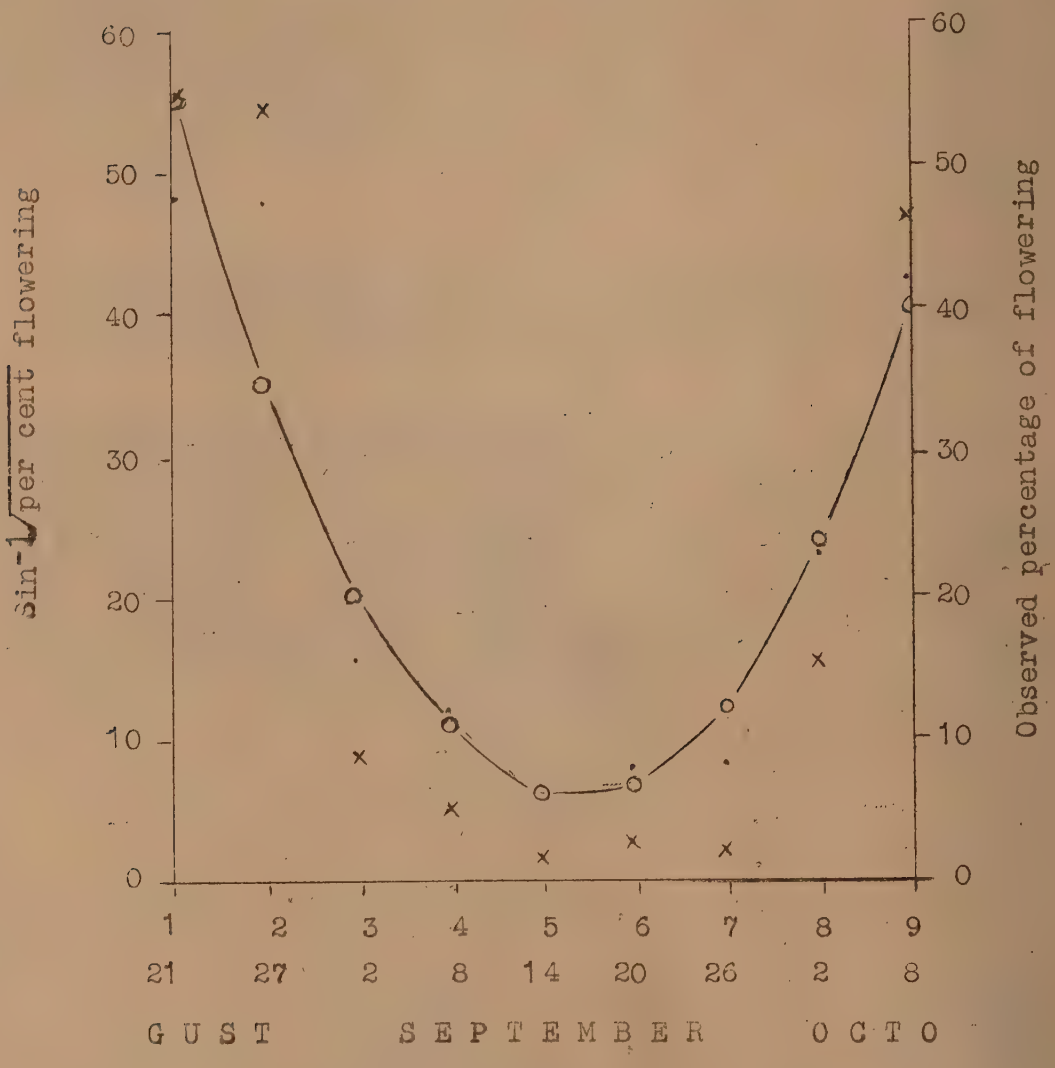
Percentage of flowering and short-blade stalks at harvest in the varieties Co.1062 and Co.1207 as influenced by dates of defoliation

Defoliated on		Spindle cluster (including the blade of the top-most dewlap) removed				Spindle cluster and three leaves removed	
		Co.1062		Co.1207		Co.1207	
		Mean percentage of flowering	Data transformed by $\sin^{-1}\sqrt{\text{per cent}}$	Mean percentage of flowering	Data transformed by $\sin^{-1}\sqrt{\text{per cent}}$	Mean percentage of flowering	Data transformed by $\sin^{-1}\sqrt{\text{per cent}}$
August	21	55.3	48.2	—		—	—
"	27	54.5	48.1	—		—	—
September	2	8.7	15.7	—		—	—
"	5	—	—	26.7	29.7	—	—
"	8-9	5.0	12.0	20.2	26.6	15.2	23.2
"	14-15	1.7	6.5	4.3	9.0	2.6	7.8
"	20	2.9	8.2	—	—	—	—
"	23	—	—	8.8	15.8	0.9	3.8
"	26	2.4	8.1	—	—	—	—
October	2	15.7	23.3	—	—	—	—
"	8	46.6	42.8	—	—	—	—
Control		53.0	46.6	55.2	48.9	55.2	48.9
LSD at 5 per cent level		—	4.2	—	5.7	—	5.7

— The treatment was not given

The treatments showed a clear but sharp downward gradient in flowering from end-August to the 3rd and 4th weeks of September when the maximum suppression occurred, followed by an equally sharp upward gradient (fig.3).

Fig.3 Percentage of flowering in Co.1062 as influenced by dates of defoliation


Sin⁻¹√per cent flowering
Observed percentage of flowering
60
50
40
30
20
10
0
1 2 3 4 5 6 7 8 9
21 27 2 8 14 20 26 2 8
G U S T S E P T E M B E R O C T O
X-values and defoliation dates

XX Observed percentage of flowering; ..Data transformed by $\sin^{-1}\sqrt{\text{per cent}}$ and oo expected values.

The percentage of flowering decreased from 55.3 to 1.7 within the four weeks; the period of substantial suppression was about 15 days ending 26th September, and the treatment was totally ineffective by the 8th of October.

The mathematical curve for the flowering of Co.1062 was worked out and is represented by the equation $y = 2.58x^2 - 27.72x + 80.56$ where 'y' represents the expected $\sin^{-1}\sqrt{\text{per cent}}$ value and 'x' denotes the defoliation date. This empirical curve fits significantly with the observed values giving the Chi-square

value 8.92 on 7 degrees of freedom.

The critical period was the same for both the varieties tested. Although the critical period is well-marked for all practical purposes, defoliation is substantially effective in the whole month of September. The day-length for the critical weeks varied from 12 hr. 2 min. to 12 hr. 20 min.

Regarding the organs concerned in perception of photoperiod the results suggest (Table 43) that the young expanding blades of the spindle cluster including the blade of the top-most dewlap constitute the principal sensitive organ for the perception of photoperiodic stimulus; the sensitivity however seems to extend to some extent to the next lower three leaves also.

TABLE 44

Juice-quality of the varieties Co.1207 and Co.1062 as affected by flowering and defoliation*

Treatment		Pol per cent juice	Purity
1. Variety Co.1207			
A. Spindle cluster removed on			
September	5	11.70	75.4
"	9	12.40	79.1
"	15	12.40	78.3
"	23	15.51	78.3
B. Spindle cluster and three leaves removed on			
September	9	12.52	79.2
"	15	12.03	78.9
"	23	13.06	79.8
C. Control		11.19	77.49
2. Variety Co.1062			
Spindle cluster removed on			
August	21	15.90	84.1
September	14	15.89	83.1

* In the case of Co.1207 only one replication was analysed while in the case of Co.1062 four replications were analysed and the average figures are given in the table.

Among the two treatments in Co.1062 viz. stalks defoliated in August in which the percentage of flowering was 55.3 and the stalks defoliated in September in which the percentage of flowering was 1.7, no differences were observed in pol per cent juice; in Co.1207, the pol per cent juice was found to be higher in the treatments in

which the percentage of flowering was reduced by defoliation than in the control. This aspect however requires more detailed and precise investigation.

5. Studies on germination

i) Loss of moisture through different parts of the sett .- A rough estimate of the loss of moisture taking place from different parts of the surface of the standard 3-budded sett was attempted to be obtained by coating different parts of the sett with bees-wax and allowing evaporation to take place from the portions left exposed.

TABLE 45

Loss in weight of setts in which different parts were exposed

Treatment	Mean percentage loss in weight after			Data transformed by $\sin^{-1}$/per cent		
	1 day	2 days	3 days	1 day	2 days	3 days
1. Control (all parts exposed)	5.9	9.5	12.7	14.1	18.0	20.9
2. Only buds exposed	1.3	2.2	3.3	6.4	8.4	10.4
3. Only cut ends exposed	2.7	4.1	5.6	9.5	11.7	13.7
4. Only internodes exposed	3.0	5.8	9.1	9.9	13.9	17.4
5. Only root-eyes exposed	1.0	2.1	2.8	5.8	8.2	9.6
LSD at 5 per cent level	-	-	-	0.9	1.2	1.4

During the first 24 hours the loss in weight of the setts in which only cut ends were exposed was about the same as the loss in weight of the setts in which only the internodes were exposed, but in the subsequent 48 hours the loss in weight was higher in the latter setts than that in the former.

Presuming that the loss in weight is largely due to the loss in moisture of the setts, it may be inferred that during the first 24 hours the loss in moisture occurs at about the same rate both through the cut ends and through the internodes. During the subsequent 48 hours the loss through the cut ends gets reduced, while that from the rind-surface is maintained more or less at the same rate.

ii) Effect of preventing loss of moisture from the setts on their germination.- In order to see whether the moisture in the internode is enough for the germination of the bud, and to ascertain which of the two internodes meeting at the bud supports to the germination of

the bud, single budded setts of variety Co.453 cut suitably (Table 46) were coated with bees-wax leaving only the buds uncoated. Thirty-six buds taken from 9 canes were used in each treatment and the setts were kept in the open inside the laboratory.

TABLE 46

Effect of coating with wax, single budded setts (with upper or lower internode) on the germination and growth of buds

Treatment	Percentage of germination after				Average height of the shoot (to the tip of the longest leaf) in cm. after			
	6 days	10 days	24 days	39 days	6 days	10 days	24 days	39 days
Wax-coated								
i. Setts with only internode below	80.5	83.3	91.7	91.7	2.7	5.6	9.9	10.3
ii. Setts with only internode above	86.1	91.7	91.7	91.7	2.7	7.5	19.2	20.2
Not coated with wax								
iii. Setts with only internode below	Not germinated							
iv. Setts with only internode above								
LSD at 5 per cent level	-	-	-	-	-	2.1	5.2	5.4

About 90 per cent of the setts in which loss of moisture was prevented by wax coating germinated and their shoots continued to grow to a considerable period, showing that the moisture in the setts is adequate for the germination of the buds. There was no germination in setts which were not coated with wax. The position of the internode did not seem to make much difference to the germination, but the growth of the shoot was better in the sett with the relevant internode of the phytomer.

iii) Pattern of distribution of moisture in fresh vs. germinating setts.- In order to ascertain the changes in the distribution of water in germinating setts the moisture content of the various parts of 1) fresh and 2) wax-coated germinating setts was estimated.

TABLE 47

Moisture per cent green weight of the various parts of fresh and germinating setts

Treatment	Bud	Node	Internodal region from node of the concerned bud				LSD at 5 per cent level
			1st quarter	2nd quarter	3rd quarter	4th quarter	
1. At start (fresh setts)	70.42	72.01	73.20	73.43	73.77	73.80	-
2. After 5 days (wax-coated setts)	76.88	71.12	73.33	73.45	73.33	73.22	-
3. Same as 1 above but data transformed by $\sin^{-1}\sqrt{\text{per cent}}$	57.08	58.08	58.83	58.98	59.19	59.21	1.10
4. Same as 2 above but data transformed by $\sin^{-1}\sqrt{\text{per cent}}$	61.26	57.51	57.91	57.97	57.91	57.84	0.83

In the fresh setts the moisture per cent of the bud was significantly lower than that of the other regions, while the reverse was the case in the germinating setts after 5 days. This suggests a movement of water towards the bud; the absence of signs of moisture depletion in the internodal portion is possibly due to the large disparity in size as between the bud and the internode.

AGRICULTURAL ENGINEERING

1. Study and improvement of agricultural implements at present used for sugarcane cultivation in different region

Blade harrow for inter-row cultivation in sugarcane.- In the preliminary trials conducted last year on the use of blade harrows for inter-row cultivation in sugarcane, it was observed that although the implement did a very satisfactory job of weeding in that most weeds were pulled out by the roots with the minimum disturbance of soil, the blade tended to become clogged with weeds and when thus clogged it failed to give satisfactory penetration. In large-scale trials, especially in fields heavily infested with weeds, it was found necessary to lift the implement out of the soil at very frequent intervals and remove the weeds from the blade. Experiments were conducted during the year under report with several different blade shapes with a view to evolving a self-clearing blade.

The self-clearing action on curved blades was found to fall short of requirement until the radius of curvature of the blade was reduced to as little as the width of cut. A 'V' shaped blade with a 90° apex angle was found to be self-clearing to about the same extent as a semi-circular blade. But both 'V' shaped blades and curved blades with large curvature necessitated the use of an additional vertical support and when this was provided, some amount of clogging in the region of the supports occurred. The supports have therefore been redesigned and further tests are in progress.

2. Field testing of sugarcane implements designed and manufactured in the country by private agencies or imported from abroad and 6. Mechanisation of sugarcane cultivation

A Landmaster Tropical Tiller equipped with a 4.5 hp. two-stroke petrol engine was obtained from the Indian Agricultural Research Institute, New Delhi and tests were carried out at the Institute Farm to determine whether this power unit could be used for cane cultivation on small holdings.

This tiller was found to be capable of ploughing 0.02 to 0.03 hectares per hour with a fuel consumption ranging from about 36 to 54 litres per hectare. The maximum depth of ploughing obtained was only 10 cm., beyond which depth the engine frequently stalled and the percentage wheel-slip became excessive.

With the rotavator attachment, although it was possible to reduce the soil to a fine tilth in one pass, the forward speed of the machine was only of the order of 3 cm. per second, and the outturn was correspondingly low; the fuel consumption in these cases was of the order of 79.5 litres per hectare. When however this tilth was sought to be obtained by repeated rotavations, it was found that fields once ploughed with the tiller needed 3 or 4 rotavations for being reduced to a satisfactory tilth, the outturn for each rotavation varying from 0.05 to 0.03 hectares per hour and the fuel consumption ranging from 5 litres to 4.5 litres per hectare. In the total, this method

of working was found to be more economical. The depth of cultivation obtained did not exceed 10 cm. and was therefore not entirely satisfactory for planting sugarcane.

In fields that had previously been deep ploughed by a conventional tractor, five successive rotavations with the tiller produced a satisfactory tilth to a depth of 12.5 cm.

All things considered, it would appear that in so far as cane cultivation is concerned the Landmaster Tropical Tiller could possibly be used profitably only for light cultivation operations. It is therefore proposed to test the machine for inter-row cultivation, fertiliser drilling and insecticide spraying in the coming year.

3. Designing and fabricating improved bullock-drawn and tractor-drawn implements and other machinery for sugarcane cultivation

IISR Bullock-drawn Sugarcane Planter.- As a result of experience gained during the past few years from using the IISR Bullock-drawn Sugarcane Planter for planting sugarcane at the Institute farm, it was observed that with a little revision in the organisation of the work team operating the machine, a greatly increased outturn could be obtained. A medium-scale field trial was therefore conducted to assess the outturn that this machine is capable of. The planting material was distributed in convenient lots at the head-lands near the ends of each row to reduce the time required for replenishing the seed boxes on the planter. The men employed for replenishing the seed boxes also planted and dressed up the rows at the head-lands. The trial proved that a well organised team of 9 men and one pair of bullocks can easily plant over 1.62 hectares (4 acres) in an 8-hour working day with the aid of this machine and that the cost of planting works out to Rs.11.55 per hectare (Rs.4.62 per acre). In the trial itself, the rate averaged to about 2.43 hectares (6 acres) per day.

The manufacturing rights for this planter have been assigned by the National Research Development Corporation of India, New Delhi, to M/S. Steel Engineering Corporation, Lohani Marg, Saharanpur, U.P. and M/S. Telipara Engineering and Foundry Works, Telipara, P.O. Kotdwara, Distt. Bijnor, U.P. These firms were given the necessary technical advice regarding manufacturing details; the first proto-types manufactured by them were tested at the Institute farm and defects in manufacture noted were pointed out for rectification and incorporation in manufacture. 15 units were reported by the manufacturers to have been sold. In order to obtain first-hand information on the machine in use in the rural areas, the purchasers of these units were contacted, and detailed operating instructions were furnished to parties who had experienced any difficulty in operating the machine.

4. Devising ways and means for conserving irrigation water

i) Experiments with polyethylene lay-flat tubes.- Experiments with transparent polyethylene lay-flat film for

conveying irrigation water were continued for the second year. The observation was that the pin-hole punctures which occurred rarely in the first year developed in the second year in such large numbers and at such frequent intervals that satisfactory repair became a problem. It was obvious that the punctures could not have been caused in handling the film, because a few lengths of the film which had been laid on for use and were not wound up at the end of each irrigation also developed these punctures in equally large numbers. It is inferred that the punctures were the result of photo-degradation to which transparent polyethylene film is subject. Film with carbon black incorporation in it is reported to be less subject to this type of deterioration. Black film which has since become available in small quantities in India, has now been obtained and is under test.

ii) Study of the distribution of irrigation water in the soil.- A preliminary experiment was conducted to determine the distribution of irrigation water in the soil under different methods of application, namely, flood irrigation and furrow irrigation. An attempt was made to obtain a dye or colouring material which when added to the irrigation water would leave a clearly visible trace in the soil-profile of the region through which the irrigation water had penetrated. A number of such materials was tried but none of them was able to afford a precise impression of the seepage, penetration and spread. From visual observations made on the soil profile in test pits, it was possible to obtain only a rough outline of the penetration and spread of water in greatly dried soil layers; these have indicated the economy of irrigating in furrows and strips. Where the soil contained a fair amount of moisture all over the profile, the observations were not clear and the tests were therefore not conclusive.

5. Exploring possibilities of overhead irrigation of sugarcane

An experiment to assess the effect of overhead irrigation on the rate of growth of cane was conducted in 3 randomised blocks with Co.951. The treatments were overhead irrigation and irrigation (control). The crop was planted on 10th February 1960 and was about 1 metre high when the overhead irrigation treatment was commenced on 14th May 1960. The plots had received 2 surface irrigations before this date. The overhead irrigation was given every day from 11 a.m. to 3 p.m. each plot receiving about 4,500 litres of water per day. Growth was recorded at weekly intervals.

The data show that on the 15th day after the commencement of overhead irrigation, the growth of plants in the overhead irrigation treatment was 9 times more than that in the control which had received the last surface irrigation 30 days earlier. The foliage of these plants was also found to be more lushy. There was no difference in tillering.

Overhead irrigation had to be discontinued from 28th May 1960 due to a breakdown of the pumping engine. The entire crop including the control which grew heavily, unfortunately lodged severely in the strong winds which blew

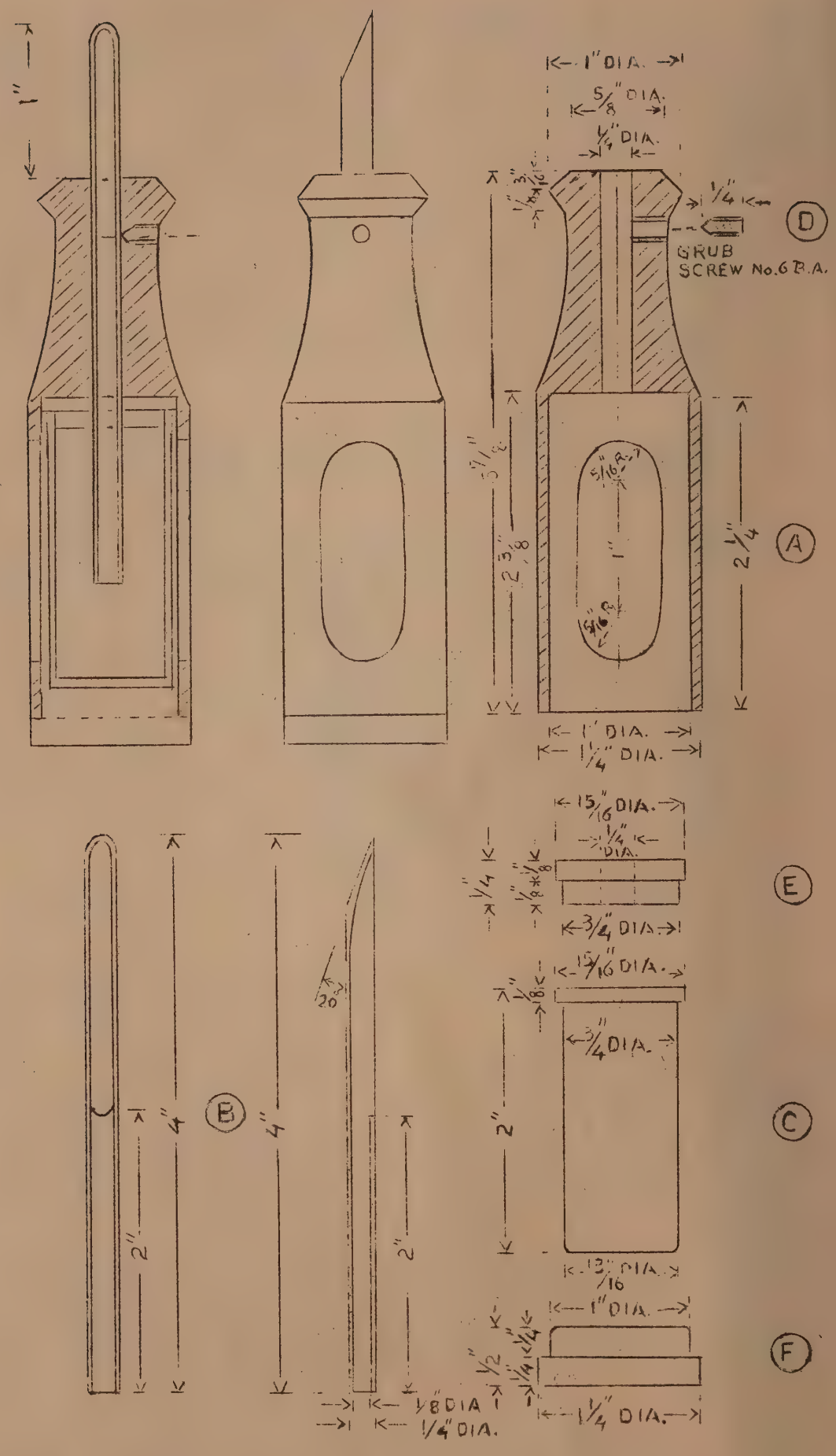


Plate 2. IISR Cane Juice Sampler

in October, and a good part of the crop dried up. Yield data were therefore not taken.

There was an indication in the data that the rate of growth of overhead-irrigated canes was less than that of the surface-irrigated canes during the monsoon period.

7. Miscellaneous

i) The IISR Cane Juice Sampler.- A cane juice sampler was designed and manufactured for collecting from standing cane composite samples of juice in small quantities for micro-analysis and for assessment of brix by the hand-refractometer.

The instrument, since named the IISR Cane Juice Sampler, (Plate 2) consists of a cast aluminium handle A, machined to take a stainless steel puncturing needle B and a polyethylene capsule C. The needle B is locked in position on the handle with a grub screw D. It has a cutting edge shaped like a gouge chisel. This cutting edge neatly severs the fibres when pushed into a cane stalk and does not split the stalk as a pointed needle does. The juice from the puncture runs down the groove in the middle of the needle and collects in the capsule C. Since the needle extends half-way down into the capsule, it prevents the juice collected in the capsule from running out even when the sampler is held point down-wards. The polyethylene seal E provides a leak-proof seat for the capsule which is held in position by the cap F, also made of polyethylene. The window openings GG facilitate the insertion and removal of the capsule and inspection of its contents when desired.

For drawing samples from a crop the sample collector takes with him into the field the juice sampler, and as many clean, stoppered and labelled capsules as the number of samples he wants to draw. He removes the cap F from the sampler, inserts the first capsule (without its stopper) into the sampler and secures it in place by putting back the cap F. He then pushes the needle into the stalk from which he wants to draw a sample, and then levers its point slightly upwards by depressing the handle. The few drops of juice thus squeezed out from inside the stalk, flow down the needle groove and collect in the capsule. This process is repeated with other stalks, till his sample is made up. It is necessary to see that the capsule is not more than half-full, or if it is, then the instrument is not held with its needle down, lest the juice should flow out. When the sample is collected, the cap F is removed, the sampler held with the needle-point upwards, and the capsule is released from its seat by drawing it off with the thumb and fore-finger through the windows GG. The stopper is then put back on the capsule and the sample is labelled. A second capsule for the second sample is immediately inserted in place of the first one and the cap F is put back to hold the capsule in place. The instrument is then ready for the second sample.

The IISR Cane Juice Sampler has been found to work efficiently in field use. It is easy to handle, to operate, and to clean; there are no screwed caps or breakable parts, and the chances of evaporation from the sample

are reduced to a minimum. It is an improvement over other samplers in these respects and also in that in it the juice collecting reservoir and handle are conveniently combined. Its cost is very low, being estimated at Rs.10 each.

ii) The IISR Cane Incisor.- In a variety of experiments in Agronomy, Physiology and Mycology, the need often arises for making a circular peripheral incision to predetermined depths into the rind on a large number of cane setts, or for cutting setts without distorting, cracking, splitting or otherwise damaging the rind, as happens when a mattock or garasi is used.

An instrument for this purpose (Fig.4) was therefore designed. This instrument is essentially a pair of pliers with 2 flat V-shaped jaws A and B. Two knife-blades D and E are fixed one on each jaw. As the maximum depth of the incision is the width of the cutting knife-blades projecting beyond the edge of the jaw, provision was made for obtaining incisions of different depths by making the projection of the blade beyond its seat adjustable. For this purpose slotted holes were provided in the knife-blades.

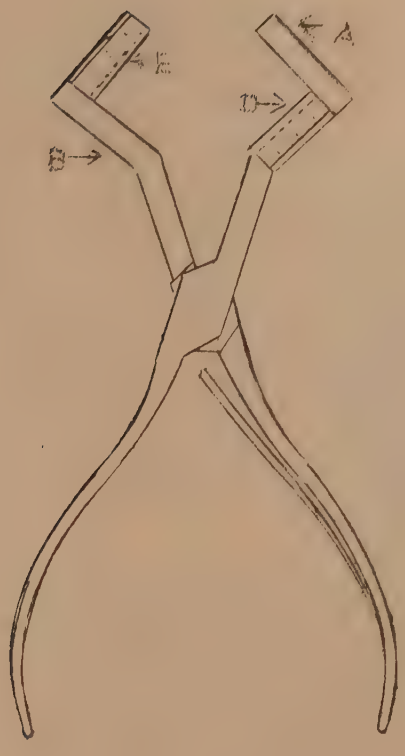


Fig.4 IISR Cane Incisor

For making the incision, the cane stalk is gripped between the two 'V's of the two jaws and the incisor is merely turned a half-circle round the cane pressing the cutting edge down gradually to the full depth. The four lines of contact between the cane and the jaws of instrument are of sufficient extent to ensure a correct alignment of the cane at right angles to the plane of the cut. Tests carried out with this incisor showed that it satisfied the requirements of the experiments for which it has been designed.

iii) Continuous removal of mud from sulphited cane juice by centrifuging.- Based on earlier studies, a design for a modified centrifuge for removal of mud from sulphitated cane juice was worked out and an experimental unit was got manufactured by a firm in Calcutta. The modified unit was however received very late in the season and it was possible to conduct only one trial. Considerable difficulty was experienced in operating the centrifuge as a result of excessive oscillation during a brief spell in the acceleration phase. This necessitated the carrying out of certain further modifications. The modified design will be tested again during the next season.

MYCOLOGY

1. Red rot

i) Mechanism of resistance: Physiology of the fungus.- (a) Nitrogen uptake - The uptake of nitrogen from inorganic and organic sources and the growth and sporulation of isolates D and I of red rot organism were studied. The experiment was conducted at the room temperature, using equal amounts of nitrogen on modified Richards' medium, treatments replicated thrice. The final filtration was done 30 days after seeding.

TABLE 48

Growth of isolates D and I of *Colletotrichum falcatum* in modified Richards' medium

Nitrogen source	Isolate I		Isolate D	
	Average dry weight (mg.)	Sporulation	Average dry weight (mg.)	Sporulation
Potassium nitrate	592.2	sparse	349.7	high
Asparagine	648.9	nil	309.9	nil
Glutamic acid	763.4	nil	471.5	sparse
Glycine	369.5	nil	233.7	nil
Methionine	409.2	nil	107.4	nil
Alanine	664.4	nil	376.8	high
Leucine	249.0	nil	121.2	sparse
Aspartic acid	583.5	nil	58.6	sparse
Mixture of all amino-acids (given above)	202.6	nil	128.7	nil

It is apparent from table 48 that the two isolates differ in their preference for the source of nitrogen. They can be separated on basis of their sporulation when grown on alanine.

The cultural filtrates were analysed qualitatively for the presence of the amino-acids by two dimensional paper chromatography. The results confirmed the earlier data (vide Physiology Report p.60).

(b) Effect of concentration of sucrose on growth of fungus - The growth and sporulation of isolates I and LR 6, were studied with different doses of sucrose provided as a source of carbon in modified Richards' medium duly sterilised and seeded. The weight of one month old fungal mat developed at 32°C in 3 replications was recorded.

The growth of the fungus increases with increasing doses of sucrose upto 10 per cent in both cases (Table 49). The effect of a higher dose is opposite in the two cases. Of the two, as observed in experiment (v) below, LR 6 is more virulent and that on a larger number of varieties, than isolate I.

TABLE 49

The effect of different concentrations of sucrose on growth of C. falcatum

Sucrose per cent medium	Isolate I		Isolate LR 6	
	Dry weight of the fungal mat (mg.)	Sporulation	Dry weight of the fungal mat (mg.)	Sporulation
0	No growth	No growth	No growth	No growth
2.5	328.0	nil	236.7	Present
5.0	593.2	"	477.1	"
7.5	967.6	"	772.0	"
10.0	1236.5	"	1137.6	"
12.5	1534.9	"	687.9	"

(c) Effect of iron and zinc on growth of fungus - In another experiment 0, 20, 40, 80, 160 and 240 ppm. of ferrous sulphate was incorporated in the basal medium. Small differences were observed in the rate of growth of the two isolates at all levels of iron; there were no differences in sporulation. It appears that iron is needed by the organism, if at all, only in traces.

The requirements of zinc were similarly tested and it was observed that zinc at 160 ppm. in the basal medium was favourable for the growth of both the isolates. There was no effect on sporulation in either case. At all levels, the growth of isolate I was more than that of LR 6.

These experiments suggest that higher rate of growth of the red rot fungus is not an indication of its higher virulence, at least in the two isolates tested.

ii) Stalk resistance of varieties.- (a) Tests by plug inoculations - Fifty canes of each of 150 varieties were inoculated with profusely sporulating cultures of isolate D of C. falcatum in August/September, 1960. The IISR inoculator and the standardised inoculum technique were employed. The final observations were made in March, 1961.

TABLE 50

Varieties classified on the basis of observed susceptibility to red rot infection by plug method

Infection per cent stalk length	Varieties
1	2
0-10.0	Nil
10.1-20.0	Co.1060, Co.1100, Co.1152, Co.1216, Co.1236 and B.0.3
20.1-30.0	Co.453, Co.1058, Co.1109, Co.1114, Co.1115, Co.1158, Co.1162, Co.1163, Co.1198, Co.1205, Co.1208, Co.1227, Co.1233, Co.1270, Co.1303, Co.1304, Co.S.416 and B.0.30

1	2
30.1-40.0	Co.213, Co.622, Co.969, Co.975, Co.976, Co.1104, Co.1106, Co.1107, Co.1111, Co.1119, Co.1130, Co.1144, Co.1173, Co.1181, Co.1191, Co.1199, Co.1222, Co.1226, Co.1261, Co.1300, Co.1305, B.0.9 and B.0.15
40.1-50.0	Co.959, Co.1101, Co.1102, Co.1108, Co.1112, Co.1113, Co.1118, Co.1138, Co.1142, Co.1149, Co.1157, Co.1177, Co.1184, Co.1186, Co.1207, Co.1209, Co.1215, Co.1217, Co.1221, Co.1223, Co.1258 and Co.S.510
50.1-60.0	Co.419, Co.951, Co.1105, Co.1116, Co.1122, Co.1129, Co.1164, Co.1167, Co.1180, Co.1182, Co.1185, Co.1194, Co.1202, Co.1203, Co.1210, Co.1234, Co.1244, Co.1260, Co.K.32, Co.L.9, Co.S.443, B.0.14 and B.0.24.
60.1-70.0	Co.527, Co.967, Co.1117, Co.1153, Co.1189, Co.1206, Co.1245, Co.1249, Co.1306 and B.0.29
70.1-80.0	Co.331, Co.998, Co.1121, Co.1132, Co.1183, Co.1220 and Co.1235
80.1-90.0	Co.313, Co.644, Co.963, Co.1176, Co.1213, Co.1225, Co.1238, Co.1240 and Co.1254
90.1-100.0	Co.312, Co.1154, Co.1156, Co.1168, Co.1188, Co.1200, Co.1232, Co.1246 and Co.1252.

$$\text{Infection per cent} = 100 \times \frac{\text{length of infection}}{\text{length of stalk}}$$

The observations indicate that the varieties Co.1060, Co.1100, Co.1152, Co.1216, Co.1236 and B.0.3 may be classified as moderately resistant to isolate D, and Co.312, Co.1154, Co.1156, Co.1168, Co.1188, Co.1200, Co.1232, Co.1246, and Co.1252 as highly susceptible.

(b) Nodal resistance - Twenty standing canes of each of 140 varieties were inoculated by pouring 1 cc. of spore suspension of sporulating cultures of isolate D between the leafsheath and the stalk. The inoculations were done on the 4th, 5th, 6th and 7th nodes of the phytomer of the topmost dewlap in September, 1960; the final observations were recorded in March, 1961. In general, infection was not as high as in the previous year.

TABLE 51

Varieties classed according to extend of root primordial infection

Class intervals for per cent stalk showing infection through root primordia	Varieties
1	2
0.0	Co.969, Co.1054, Co.1213, Co.1215, Co.1217, B.0.9 and B.0.14

1	2
0.1-5.0	Co.527, Co.622, Co.976, Co.1029, Co.1055, Co.1074, Co.1084, Co.1086, Co.1107, Co.1167, Co.1183, Co.1193 and Co.1240
5.1-10.0	Co.453, Co.617, Co.1013, Co.1023, Co.1025, Co.1031, Co.1040, Co.1051, Co.1063, Co.1070, Co.1072, Co.1076, Co.1085, Co.1111, Co.1112, Co.1114, Co.1115, Co.1118, Co.1119, Co.1121, Co.1154, Co.1161, Co.1162, Co.1169, Co.1173, Co.1180, Co.1182, Co.1191, Co.1198, Co.1210, Co.1236, Co.1303 and Co.S.416
10.1-20.0	Co.312, Co.313, Co.432, Co.644, Co.951, Co.959, Co.997, Co.1020, Co.1027, Co.1030, Co.1033, Co.1034, Co.1036, Co.1039, Co.1048, Co.1058, Co.1060, Co.1062, Co.1071, Co.1075, Co.1078, Co.1079, Co.1080, Co.1081, Co.1087, Co.1089, Co.1095, Co.1101, Co.1104, Co.1108, Co.1109, Co.1132, Co.1168, Co.1176, Co.1177, Co.1181, Co.1194, Co.1199, Co.1207, Co.1208, Co.1270, B.O.4, B.O.11, B.O.15, B.O.29 and Co.L.9
20.1-30.0	Co.419, Co.967, Co.1024, Co.1073, Co.1077, Co.1105, Co.1152, Co.1158, Co.1221, Co.1227, Co.1235, Co.1249, Co.1261, Co.1302, Co.1304, Co.1305 and Co.1307.

iii) Deterioration of juice-quality in diseased stalks due to red rot.- Brix of a stalk infected with C. falcatum is lowered due to the invertase activity of the fungus. An experiment was taken up at the instance of the Indian Central Sugarcane Committee to study the comparative behaviour of varieties in this regard in 1959-60 and repeated this year. Brix of artificially inoculated as well as uninoculated sugarcane stalks of 20 varieties was assessed by hand-refractometer fortnightly, between November, 1960 and January, 1961. One reading was recorded from each of five inoculated stalks per variety per observation. Maximum differences between the brix of diseased and healthy stalks were recorded in Co.312 and Co.527 on 21st December, 1961, whereas in all others it was on 28th January, 1961.

TABLE 52

Loss in brix of stalks inoculated with C. falcatum

Variety	Per cent loss	Variety	Per cent loss	Variety	Per cent loss
Co.312	37.9	Co.951	69.5	Co.998	53.4
Co.313	35.9	Co.959	69.1	Co.1161	65.0
Co.331	49.5	Co.963	61.3	Co.1162	62.8
Co.419	49.4	Co.967	54.3	Co.S.443	60.4
Co.453	72.7	Co.969	63.6	Co.S.510	49.7
Co.527	44.0	Co.996	43.5	B.O.11	74.8
Co.617	51.1	Co.997	31.8		

The figures (Table 52) show that varieties behave differently in the loss of brix due to the infection. No correlation seems to exist between the linear spread of the disease and loss in brix due to infection within a variety.

iv) Response of stalks of different age-groups to inoculations with C. falcatum by plug method.- In a study of the possible causes for the large variation met with in the linear infection of cane stalks, an experiment was initiated last year on the age of stalks. It was repeated this year with 20 varieties and isolate D of C. falcatum. Stalks of different age-groups of a variety, tagged on emergence were inoculated with the IISR inoculator in October, 1960. The final observations (Table 53) were recorded in March 1961.

TABLE 53

Spread of red rot infection in inoculated stalks of different age groups

Variety	Infection per cent length of stalks of age (in days)						
	58	85	94	122	141	159	183
Co.312	100	100	100	67.3	100	100	100
Co.313	*	*	18.1	29.0	12.5	14.8	16.3
Co.331	*	4.7	53.2	9.5	15.0	38.0	18.6
Co.419	*	*	100	100	37.9	80.0	79.2
Co.453	*	100	26.2	3.3	8.3	6.8	23.0
Co.527	*	57.1	84.2	42.4	37.6	57.1	52.4
Co.617	22.6	6.1	21.8	9.7	18.8	11.2	11.8
Co.975	*	*	8.5	21.5	28.0	37.8	16.0
Co.1058	23.3	62.5	100	60.1	53.7	64.8	25.2
Co.1051	*	57.6	72.1	43.0	26.6	40.1	15.9
Co.1057	15.1	18.4	23.1	20.8	27.9	20.1	21.4
Co.1078	*	100	40.5	16.9	18.9	22.1	28.0
Co.1080	*	*	35.5	39.9	82.9	46.9	44.8
Co.1085	*	14.3	31.8	27.3	45.7	27.3	21.4
Co.K.32	*	10.5	11.3	11.4	8.5	64.5	12.0
Co.L.9	53.0	14.0	37.0	14.4	24.5	38.0	37.7
B.0.3	*	11.7	14.8	11.4	16.9	7.5	8.0
B.0.10	10.3	14.0	7.5	8.1	3.7	6.5	8.5
B.0.11	36.9	31.5	17.3	15.2	18.3	30.1	19.8
B.0.14	100	100	100	100	100	100	100

* = No shoots of this age-group were available.

The data show considerable variation among the age-groups; it appears therefore that age of stalks is not one of the factors affecting the spread of infection in the stalk.

v) Comparative virulence of different isolates of C. falcatum.- The experiment was initiated in 1959-60 with 2 varieties and 24 isolates. This year 11 new isolates, collected from Uttar Pradesh were added and all except isolate 1P were tested on 10 varieties, 20 stalks each.

TABLE 54

Extent of infection with different isolates of C. falcatum

Isolates	Varieties									
	Co. 312	Co. 313	Co. 385	Co. 419	Co. 453	Co. 527	Co. 617	Co. 997	Co.S. 443	Co.S. 510
LR 1	-	-	-	-	B	-	-	A	-	B
LR 2	-	-	-	-	B	-	-	-	A	C
LR 3	-	B	-	-	C	-	-	B	-	C
LR 4	B	-	C	-	-	-	-	-	A	C
LR 5	B	-	-	-	-	-	-	-	-	C
LR 6	B	-	-	-	B	-	B	-	A	C
LR 7	C	-	-	-	C	-	B	-	-	C
LR 8	C	-	A	-	-	-	-	-	A	C
LR 9	C	B	-	-	-	-	-	B	A	C
LR 10	-	-	-	-	-	-	-	-	-	C
LR 11	-	-	-	-	C	-	-	-	A	C
LR 12	-	-	-	-	C	-	-	-	-	C
LR 13	B	-	B	-	C	-	-	-	-	C
LR 14	C	-	-	-	-	-	-	-	C	C
LR 15	B	-	-	-	-	-	-	-	A	C
LR 16	C	-	B	-	-	-	-	-	-	C
LR 17	C	-	-	A	-	-	A	-	-	C
LR 18	-	-	-	-	-	-	-	-	-	-
LR 19	-	-	-	-	B	-	-	-	-	C
LR 20	-	-	-	A	-	-	-	C	A	C
LR 21	B	-	-	-	B	B	-	B	-	C
LR 22	C	-	-	-	B	-	-	-	-	C
LR 23	C	-	A	-	-	-	-	-	A	C
LR 24	C	-	-	-	-	-	-	-	A	-
D	C	B	-	-	-	-	-	-	-	-
1S	-	-	-	-	-	-	-	C	-	C
2S	-	-	-	-	C	-	A	-	A	-
3S	B	A	-	-	C	-	A	-	A	-
1WB	-	-	A	-	A	A	-	A	A	-
2WB	-	A	A	A	-	A	A	-	A	C
2P	-	A	-	B	-	B	-	B	A	A
I	-	-	A	-	A	-	-	C	A	A
R.121	-	-	A	-	-	A	-	A	A	-
R.123(Sh.)	-	-	A	-	-	A	-	A	A	-

A = 0-20
- = 20-70
B = 70-100
C = 100 (complete drying)

} per cent infection of the inoculated stalks.

Data in table 54 show that the isolates differ in the degree to which they affect the tissues of the inoculated stalks. It may also be seen that the response of the varieties to a particular isolate is not the same.

The sporulation of these isolates on oat-meal agar varied from sparse to profuse. It is presumable that the sporulation of an isolate in vitro on a given medium does not necessarily mean that it is more virulent than

other less sporulating or even asporulating isolates.

vi) Dissemination of the fungus: mid-rib lesions.- For determining the role of mid-rib lesions in causing red rot of the stalks, a large number of isolations were made from naturally-affected leaves of 133 varieties. These were purified and cultured on oat-meal agar medium. It was noted that a majority of these was the non-sporulating, dark types. Only 6 per cent of the isolates sporulated in culture; these were from the leaves of Co.313, Co.331, Co.453, Co.617, Co.1169, Co.1170 and Co.1225. The sporulating isolates were inoculated into healthy stalks of the variety from which they were each originally isolated. Another set of healthy stalks of the same varieties was inoculated with isolate D, for comparison.

In practically all cases the extent of infection with mid-rib isolates was low and considerably less than that with isolate D.

The experiment has shown that the isolates causing mid-rib lesions are mostly non-sporulating, weakly parasitic strains which are not usually found in diseased stalks in nature

2. Smut

i) Physiology of Ustilago scitaminea.- For working out the nutritional requirements of the fungus, sporidial cultures of Ustilago scitaminea, LS-2, were used for seeding various synthetic and natural agar media in Petri-dishes. The diameters of the fungus colonies formed at 23°C were recorded 27 days after seeding.

TABLE 55

Growth of Ustilago scitaminea on synthetic and natural media

Synthetic		Natural	
Medium	Average diameter of the fungus colony (mm.)	Medium	Average diameter of the fungus colony (mm.)
Asparagine yeast agar	33	Oatmeal peptone yeast agar	38
Asparagine agar-A	31	Oatmeal peptone agar	34
Asparagine agar-B	22	Sugarcane juice agar	26
Czapek's agar	21	Potato dextrose agar	24
Westergaard and Mitchel agar	20	Onion agar	20
Elliot's agar	20	Oatmeal agar	13
Richards' agar	19	Pea agar	10
Pfeffer's agar	12		

Dextrose yeast agar modified with peptone, and oat-meal-agar having peptone and yeast proved to be the best for the growth of this fungus among the synthetic and natural media, respectively (Table 55). Addition of peptone and yeast appears to favour the growth of the culture LS-2.

The effect of temperature on the growth of LS-2 was also studied by comparing the diameters of colonies of this fungus grown on asparagine yeast agar (A) after 21 days of incubation of the seeded dishes. The temperature levels maintained under this experiment were 23°C, 26°C, 28°C, 31°C and 35°C. The size of the colonies showed that the optimum temperature for the growth of the fungus is 28°C.

In a similar experiment, the optimum pH for the growth of the smut fungus (LS-2) was determined to be 5.6. For this experiment the levels of pH were adjusted in suitably buffered media. These were pH 3.05, 3.75, 4.25, 5.12, 5.60, 5.80, 6.30 and 6.45.

The utilisation of organic nitrogen by this fungus for its growth was repeated with isolate LS-2. The amino-acids included in this experiment were l(-) asparagine, l(+)-cysteine hydrochloride, betaine, glycine, methionine, d,l aspartic acid, taurine, d,l phenyl alanine, d,l isoleucine, d,l alanine, l(+) glutamic acid, d,l serine, l argenine and d,l valine. Of these, l(-)-asparagine and methionine proved respectively to be the best and the worst sources for the supply of amino-nitrogen in synthetic media.

The effect of the concentration of l(-)-asparagine, the most suitable source for the supply of amino nitrogen, was studied on a liquid basal medium. The pH was adjusted at 5.6 in suitably buffered media. It was observed that 0.1 per cent concentration of asparagine was better than the higher doses 0.2, 0.3, 0.4 or 0.5 per cent.

iii) Studies on physiologic specialisation of Ustilago scitaminea.- (a) Nutritional - With a view to studying the physiological difference if any, within the species on the basis of cultural characteristics, smut spores were collected from a number of naturally infected varieties growing in various localities of Uttar Pradesh. These were separately grown on a suitable artificial medium as pure cultures. The seeded Petri-dishes were incubated in 6 replications for 21 days at 25°C, following which the diameters of the colonies were measured.

TABLE 56

Mean diameters of 21 day old fungus colonies of Ustilago scitaminea collected from different places on different varieties

Locality of collection of the fungus	Variety	Average diameter of fungus colony (mm.)
1	2	3
Indian Institute of Sugarcane Research, Lucknow	Co.963	46
.....do.....	Co.965	41

1	2	3
Indian Institute of Sugarcane Research, Lucknow	Co.1062	47
.....do.....	Co.S.510	45
Sugarcane Research Farm, Muzaffarnagar	Co.453	46
.....do.....	Co.975	45
.....do.....	Co.1033	48
.....do.....	Co.1214	48
.....do.....	Co.1228	41
.....do.....	Co.1241	45
.....do.....	Co.S.245	45
Mansurpur, Muzaffarnagar	Co.S.245	44
Tajpura, Saharanpur	Co.S.245	39
Bhula Kalsia, Saharanpur	Co.S.245	45
Dhande, Jullundur	Co.S.245	43
Dhande, Jullundur	Co.S.321	48
Naya gaon, Bulandshahr	Co.951	49
Hazratpura, Bulandshahr	Co.S.245	44

Data presented in table 56 do not show marked differences in the average growth of various isolates. It is, therefore clear that for physiologic differentiation, it is necessary to take a factor other than the linear growth of the fungus. Further studies in this respect are in progress.

(b) Longevity of different collections of the smut organism - Another factor tested out for physiologic differentiation among smut isolates was the longevity of the chlamydospores of the fungus. Here the term longevity denotes the period over which the spores remained viable. For this experiment, smut spores were obtained from the central part of smut whips of naturally infected stalks of 50 different varieties from Lucknow, Bulandshahr and Saharanpur. These were stored in small vials at 5°C. These longevity tests are still in progress.

iv) Varietal susceptibility to U. scitaminea.- The reaction of 41 agronomically promising varieties against smut inoculation was studied. Healthy, 3-budded setts of each variety were submerged in smut spore suspension (viability 89 per cent and above) for one hour just before planting. In all, five rows were planted to each variety - four with inoculated setts and one with uninoculated. Incidence of smut was recorded at fortnightly intervals, till harvest.

TABLE 57

Varieties classified on the basis of smut incidence following inoculation of seed pieces

Incidence per cent total clumps	Varieties
1	2
0-5.0	Co.312, Co.449*, Co.527, Co.617*, Co.947*, Co.997 and Co.1144

1	2
5.1-10.00	Co.957, Co.1062 and Co.1122
10.1-15.0	Co.313, Co.419, Co.943, Co.1245 and Co.1254
15.1-20.0	Co.453, Co.945, Co.963, Co.1111, Co.1161, Co.1240 and Co.1304
20.1-30.0	Co.933, Co.937, Co.976, Co.1058, Co.1087, Co.1107, Co.1142, Co.1235, Co.1301, Co.1306 and Co.S.510
30.1-40.0	Co.965, Co.1207, Co.1251 and Co.1300
40.1-60.0	Co.1173, Co.1204 and Co.1305
60.1-80.0	Co.1236
80.1-100.0	Nil

* incidence less than 2 per cent

The data (Table 57) show that Co.449, Co.617 and Co.947 may be considered as resistant.

v) Smut inoculation technique.- The present method of inoculating seed material with the smut organism for experimental purposes including varietal screening is by dipping the setts in an aqueous suspension of the viable chlamydospores before planting. This often gives erratic results. One of the probable reasons for such results could be the inoculation technique. Certain aspects of this have already been investigated for purposes of standardisation. Penetration of the inoculum was therefore taken up.

Setts of apparently healthy stalks of Co.S.510 and Co.527 were placed in a chamber under negative pressure. The suspension of viable chlamydospores was then allowed into the chamber to submerge the setts for 15 minutes. The setts so treated were then divided into three lots and these lots were incubated for 0, 48 and 72 hours in moist sawdust before planting. Corresponding controls were provided. Germination was cent per cent. The appearance of smut whips was recorded.

TABLE 58

The effect of vacuum treatment and incubation on the incidence of smut in inoculated setts

Incubation (hours)	Per cent incidence of smut			
	Co.527		Co.S.510	
	Without vacuum	With vacuum	Without cacuum	With vacuum
0	33.3	65.0	50.0	65.0
48	16.9	33.3	33.3	100.0
72	65.0	16.9	65.0	100.0

The data presented in table 58 show that the inoculation under vacuum results in a higher smut incidence than ordinary immersion. It appears that under vacuum, the suspension is able to penetrate between the tightly-clasping bud scales, and effect infection. The differences due to period of incubation vary between treatments and the factors causing this will be investigated.

3. Root rot

In June and July, 1960, many clumps of C.P.29/320 in the varietal trial were observed to rapidly dry up in the field. The roots of the affected plants when examined yielded Pythium aphanidermatum. Inoculations were made on healthy plants of Co.S.510 by mixing the soil near the root region with a culture of the fungus against suitable controls; these showed positive reaction in 26 days. The fungus was re-isolated from the roots of inoculated plants.

Populations of some plant parasitic nematodes (Hoplolaimus sp., Helicotylenchus erythrinae and Tylenchorhynchus sp.) was observed to be very high around the affected plants, in the field.

The soil round the plants of C.P.29/320 was drenched with various fungicides at the rate 500 gallons per acre in plots approximately 3 m. x 2 m. to determine whether the spread of the disease could be checked.

TABLE 59

Efficacy of soil drench with fungicides on the control of root rot

Treatment Fungicides and their concentration in 455 litres (100 gallons) of water		Per cent increase of the death of the plant (complete drying)
Fytolan	0.92 kg.	0.0
Ceresan wet	0.46 kg.	5.5
Ferbam	0.92 kg.	7.7
Agallol	0.46 kg.	11.1
Spersul	4.54 kg.	11.1
Thiram	0.92 kg.	14.3
Ziram	0.92 kg.	21.4
Parrycop	1.84 kg.	38.5
Control (no treatment)		51.8

It will be seen from the results in table 59 that drenching the soil round the plants with Fytolan has effectively checked the disease.

4. Diseases due to plant parasitic nematodes

Damage to sugarcane due to plant parasitic nematodes was recorded in several places of the country. Plant and soil samples from 14 localities were collected in eight States - U.P., Punjab, Madras, West Bengal, Assam, Bihar, Madhya Pradesh and Mysore. The nematodes were isolated by a modification of the Baermann funnel technique. In some cases fungal isolations from the roots were also made.

TABLE 60

Nematodes parasitic on sugarcane in India

Parasites	Variety	Fungi associated
	UTTAR PRADESH:	
Hoplolaimus (angustalatus) Helicotylenchus erythrinae Helicotylenchus nannus Pratylenchus sp. Pratylenchus penetrans Tylenchorhynchus ornatus Xiphinema citri Xiphinema sp. Paratylenchus sp. Longidorus elongatus	Co.313, Co.356 Co.951, Co.975 Co.S.245, Co.S.515, G.9938, G.9984 C.P.29/320	Fusarium sp. Cephalosporium sp. Pythium aphanidermatum
	MADRAS:	
Helicotylenchus erythrinae Helicotylenchus nannus Tylenchorhynchus sp. Psilenchus sp. Pratylenchus (Zeae)	Co.467, B.42261	Pythium aphanidermatum
	MYSORE:	
Tylenchorhynchus sp. Helicotylenchus erythrinae	HM 350	--------
	PUNJAB:	
Hoplolaimus sp. Criconemoides citri Pratylenchus penetrans Xiphinema citri Longidorus elongatus Helicotylenchus erythrinae Helicotylenchus nannus	Co.976, Co.L.9	Pythium sp. Cephalosporium sp.
	BIHAR:	
Hoplolaimus (angustalatus) Helicotylenchus nannus Tylenchorhynchus latus	B.0.14, B.0.22 B.0.29	—
	ASSAM:	
Helicotylenchus erythrinae Pratylenchus sp Tylenchorhynchus sp. Hoplolaimus sp.	—	Pythium sp.
	MADHYA PRADESH:	
Tylenchorhynchus dubius Helicotylenchus nannus Hoplolaimus sp. Pratylenchus sp. (Ditylenchus sp.)	Co.617, Co.S.245 Ponda	—

This preliminary survey shows that the organisms are fairly widespread in their occurrence in India. It was observed that the nematode parasitisation of the roots is usually associated with fungal attacks on the roots as well. Fusarium sp. and Pythium sp. were found to be common among the associates. Nematode-Pythium aphanidermatum complex was found to kill the plants of C.P.29/320 without any warning. Observations in the varietal trials showed that nematodes affect varieties differentially.

Meloidogyne sp. causing root-knot disease of Beta vulgaris, Type NK, at Jullundur was recorded. This is the first record of this disease for the country. Hoplolaimus sp. was also observed in the rhizosphere of the sugar beet plants.

Catenaria (vermicola) was observed attacking nematodes in several places. This is the first record of this fungus in India.

5. Minor diseases

i) Mosaic.- Mosaic disease was observed on Co.313, Co.449, Co.514, Co.527, Co.545, Co.546, Co.550, Co.617, Co.646, Co.658, Co.661, Co.687, Co.691, Co.705, Co.707, Co.714, Co.733, Co.740, Co.757, Co.793, Co.798, Co.807, Co.830, Co.854, Co.856, Co.935, Co.941, Co.950, Co.951, Co.952, Co.957, Co.959, Co.961, Co.963, Co.969, Co.975, Co.986, Co.991, Co.997, Co.1007, Co.1012, Co.1050, Co.1051, Co.1058, Co.1060, Co.1061, Co.1062, Co.1064, Co.1065, Co.1070, Co.1071, Co.1077, Co.1098, Co.1099, Co.1100, Co.1101, Co.1102, Co.1103, Co.1116, Co.1117, Co.1118, Co.1120, Co.1139, Co.1163, Co.1164, Co.1171, Co.J.33, Co.L.29 and SES.77.

ii) Twisted top.- For the last several years, planting material obtained originally from stalks showing twisted top disease is being planted in successive vegetative generations. The incidence of this disease is recorded at fortnightly intervals in the crops raised. It has been observed that the incidence of twisted top in the crops raised from this material is gradually going down. This year, the disease was observed only in traces. This is possibly a case of natural recovery. Natural recovery of affected canes from mosaic has been reported from Louisiana. This disease was observed in Co.545, Co.738, Co.946 and Co.942.

iii) Albino.- Albino was recorded on Co.281, Co.356, Co.370, Co.391, Co.432, Co.475, Co.513, Co.527, Co.603, Co.619, Co.627, Co.639, Co.640, Co.658, Co.670, Co.691, Co.711, Co.725, Co.729, Co.732, Co.738, Co.780, Co.782, Co.830, Co.856, Co.933, Co.945, Co.949, Co.951, Co.952, Co.955, Co.957, Co.959, Co.961, Co.969, Co.976, Co.978, Co.979, Co.980, Co.981, Co.983, Co.985, Co.987, Co.988, Co.993, Co.1002, Co.1016, Co.1018, Co.1019, Co.1022, Co.1023, Co.1025, Co.1026, Co.1048, Co.1049, Co.1056, Co.1057, Co.1060, Co.1064, Co.1069, Co.1071, Co.1072, Co.1073, Co.1074, Co.1077, Co.1080, Co.1084, Co.1085, Co.1092, Co.1098, Co.1102, Co.1103, Co.1107, Co.1108, Co.1109, Co.1114, Co.1115, Co.1148, Co.1164, Co.J.32, Co.L.29, Co.K.30, Co.S.555, Co.S.416 and Co.S.541.

In a varietal collection plot in district Lakhimpur it was noticed in B.O.22, B.O.28, B.O.29, B.O.31, B.O.32, B.O.35 and B.O.38.

The question of the identity of this disease with the grassy shoot is now being investigated at this Institute. Heat treatments to control this disease are also in progress.

iv) Red stripe.- Red stripe disease was observed on Co.453, Co.617, Co.997, Co.S.416, Co.S.443 and Co.S.510. The causal organism of this disease was isolated on nutrient agar.

The cultures of red rot, smut, wilt and rust organisms were maintained. Enquiries regarding the diseases were attended to.

1. Studies on toxicity and persistence of insecticides

i) Toxicity of 0.1 per cent endrin emulsion spray in relation to newly-hatched larvae of Chilotraea infuscatellus Snell.- Newly-hatched larvae of C. infuscatellus (in separate lots) were exposed to the treated surface, immediately after spraying, and later at graded intervals, up to a period of about 4 weeks after treatment. The period of exposure in each case varied from 15 minutes to 60 minutes.

TABLE 61

Mortality of newly-hatched larvae of C. infuscatellus on exposure to surface sprayed with 0.1 per cent endrin

Larvae exposed after ____ of spray	Period of exposure: 15 minutes — Cumulative mortality per cent ____ hours after exposure			30 minutes — Cumulative mortality per cent ____ hours after exposure			60 minutes — Cumulative mortality per cent ____ hours after exposure	
	0	3	24	0	3	24	0	3
15 minutes	100			100			100	
3 hours	nil	100		100			100	
6 "	"	nil	100	100			100	
12 "	"	"	100	100			100	
1 day	"	"	100	100			100	
2 days	"	"	100	100			100	
3 "	"	"	100	100			100	
4 "	"	"	100	10	100		100	
5 "	"	"	nil	nil	100		nil	100
6 "	"	"	"	"	100		"	100
7 "	"	"	"	"	100		"	100
8 "	"	"	"	"	100		"	100
9 "	"	"	"	"	100		"	100
10 "	"	"	"	"	100		"	100
12 "	"	"	"	"	100		"	100
14 "	"	"	"	"	100		"	100
16 "	"	"	"	"	100		"	100
18 "	"	"	"	"	100		"	100
20 "	"	"	"	"	100		"	100
22 "	"	"	"	"	20	100	"	100
24 "	"	"	"	"	nil	100	"	100
26 "	"	"	"	"	10	100	"	100

Effective residual toxicity of 0.1 per cent endrin spray against the young larvae was observed to last even till 26 days after treatment with 60 minutes' exposure. Since newly-hatched larvae were not available in the laboratory after that period, further observations in this regard could not be continued.

ii) Comparative toxicity of different insecticides in relation to grown up larvae of Chilotraea auricilia Ddgn.- For these studies, trials were made with promising chlorina-

ted hydrocarbons (including endrin) and certain other modern insecticides with a view to studying their comparative toxicity against grown up larvae of C. auricilia. The strengths tried were 0.1 per cent and 0.2 per cent and the period of exposure was one hour in each case. The number of larvae released under each series was 9 per unit of 3 dishes.

TABLE 62

Mortality of grown-up larvae of C. auricilia exposed to surfaces sprayed with different insecticidal sprays

Treatment	Larvae exposed after ____ of spraying	Cumulative mortality per cent among the larvae --- hours after exposure 24	48	96	144	192
1	2	3	4	5	6	7
(a) In 0.1 per cent strength (period of exposure 60 min.)						
Endrin emulsion	15 min.	nil	11	33	55	100
	24 hr.	nil	11	11	55	100
Gamma cereclor suspension	15 min.	nil	nil	nil	22	55
	24 hr.	nil	nil	nil	11	11
DDT emulsion	15 min.	11	11	11	11	11
	24 hr.	nil	nil	nil	11	11
Gamma BHC emulsion	15 min.	11	11	11	11	11
	24 hr.	nil	11	11	11	11
Sevin suspension	15 min.	nil	33	33	33	44
	24 hr.	nil	11	11	11	11
Chlorocide suspension	15 min.	11	11	22	22	33
	24 hr.	nil	nil	22	22	22
Chlorocide/Malathion emulsion	15 min.	33	67	67	89	100
	24 hr.	33	33	33	89	89
Control		nil	nil	nil	nil	nil
LSD at 5 per cent level	(exposure after 15 min. of spraying)					36.42
-do- -do-	(-do- -do- 24 hr. -do-)					34.02
(b) In 0.2 per cent strength (period of exposure 60 min.)						
Endrin emulsion	15 min.	22	78	89	89	100
	24 hr.	nil	nil	22	67	100
Gamma cereclor suspension	15 min.	nil	33	56	67	78
	24 hr.	nil	33	33	33	33

1	2	3	4	5	6	7
DDT emulsion	½15 min.	22	22	22	33	33
	½24 hr.	22	22	22	22	33
Gamma BHC emulsion	½15 min.	22	22	33	33	33
	½24 hr.	nil	22	22	33	33
Sevin suspension	½15 min.	nil	33	33	44	55
	½24 hr.	nil	11	11	11	11
Chlorocide suspension	½15 min.	nil	44	44	44	44
	½24 hr.	nil	11	11	11	11
Chlorocide/Malathion emulsion	½15 min.	100	100	100	100	100
	½24 hr.	89	100	100	100	100
Control		nil	nil	nil	nil	nil
LSD at 5 per cent level	(exposure after 15 min. of spraying)					33.68
-do- -do-	(-do- -do- 24 hr. -do-)					36.54

Only chlorocide/malathion emulsion in 0.2 per cent strength showed some promise. Under this treatment complete mortality was obtained 24 hours and 48 hours after exposure respectively when the larvae were released on the treated surface immediately and 24 hours after treatment. Lower strength of 0.1 per cent (of chlorocide/malathion emulsion) did not prove so effective. Complete mortality among the larvae under this treatment as also under endrin 0.1 per cent and 0.2 per cent strengths was observed 192 hours after exposure.

2. Studies on control of stalk borer, C. auricilia and the internode borer, P. indicus

Besides stalk borer, C. auricilia attack of internode borer, Proceras indicus Kapur, which is a serious pest of sugarcane in peninsular India, was also recorded at the Institute farm during the year under report. Trials regarding their control both in the laboratory and the field were carried out.

i) Chemical control.- An experiment for control of these two borers, the attacks of which were met with simultaneously, was laid out with Co.997 in 170 sq.m. plots replicated 3 times. The insecticidal sprays were applied twice once in September and once in October, synchronising as far as possible with the rush of moth emergence and oviposition.

TABLE 63

Efficacy of different insecticides against C. auricilia and P. indicus

Treatment	Actual quantity of insecticide applied per hectare	C. auricilia		P. indicus	
		Per cent incidence	Seizures per hectare	Per cent incidence	Seizures per hectare
Endrin 0.1 per cent emulsion	1.12 kg.	74.6	75483	31.8	30035
-do- 0.2 -do-	2.24 kg.	80.0	79000	25.3	25688
DDT 0.1 per cent emulsion	1.12 kg.	82.3	78645	29.5	32406
-do- 0.2 per cent emulsion	2.24 kg.	84.1	79633	24.0	24898
Gamma BHC 0.1 per cent -do-	1.12 kg.	71.1	79435	36.6	36358
-do- 0.2 -do- -do-	2.24 kg.	72.9	69950	25.1	26478
Endrin + Dieldrin 0.1 per cent emulsion	1.12 kg. + 1.12 kg.	76.0	82246	27.5	29640
Control	-	82.7	68370	23.0	22131

None of the treatments proved effective against any of the two borers, and the differences were non-significant. Heavy lodging of the crop in the field induced severe infestation by C. auricilia and this factor rendered the assessment of the effect of different treatments difficult.

ii) Bacterial control.- A pathogenic bacterium, a strain (HB-III) of Bacillus cereus var. thuringiensis (Berliner) was reported to have caused considerable mortality among the lab lab pod-boring caterpillars (Heliothis obsoleta F.) in Mysore area. The spore powder of this bacterium was obtained from the Head of the Division of Infestation, Control and Pesticides, Central Food Technological Research Institute, Mysore for trials against the stalk borer, C. auricilia and the internode borer, P. indicus. Trials with this spore powder were made both in the laboratory and in the field.

(a) Laboratory trials - Suspensions of the bacterial spore powder in two strengths of 1 mg. and 2 mg. each per 10 ml. of water, were sprayed on cut cane pieces placed in petri dishes and grown up larvae of stalk borer and the internode borer were released (in separate lots of 9 per treatment) on the treated surface immediately after spray. The period of exposure in each case was 30 minutes.

This treatment did not show any immediate adverse effect on the caterpillars. Cumulative mortality among the P. indicus larvae upto 144 hours after exposure was 53 to 73 per cent, while among C. auricilia larvae it was 26 to 33 per cent, only. Under 'control' there was no mortality.

(b) Field trials - The bacterial spore powder suspended in water was sprayed in two doses of 40.7 g. and 81.5 g. per hectare. Per cent incidence of the two borers was

recorded one month after treatment.

TABLE 64

Efficacy of bacterial spore powder (HB-III) of *B. cereus* var. *thuringiensis* (Berliner) against *C. auricilia* and *P. indicus*

Dose per hectare	*C. auricilia*		*P. indicus*	
	Per cent incidence on stalk basis	Per cent internodes bored	Per cent incidence on stalk basis	Per cent internodes bored
40.7 g.	67.4	12.4	20.9	6.2
81.5 g.	94.5	25.1	25.1	6.5
Control (no treatment)	72.1	18.6	18.6	6.5

The bacterial spore powder spray does not appear to have been effective.

iii) Mechanical control.- Stripping of dry leaves - The caterpillars of the stalk and internode borers migrate from cane to cane. Internode borers pupate in the leaf-sheath. With a view to finding out the effect of stripping off dry leaves on the incidence of these borers, an experiment was laid out with Co.S.443 in 310 sq.m. plots replicated three times. The dry leaves were stripped off the cane in mid-October and mid-November. Observations at harvest showed that the removal of dry leaves did not bring about any reduction in stalk borer attack. In case of the internode borer, however, per cent incidence was 13.7 in the stripped plots and 20.7 in the control. The number of internodes bored was 6.1 per cent in the stripped plots and 6.8 per cent under control. Stripping had no effect on juice-quality. Further observations will be necessary to arrive at definite conclusions.

3. Treatment of seed-cane against *C. auricilia*

Seed-cane is often transported from one locality to another for planting purposes and there is a possibility of some of the sugarcane pests being carried to new areas in this way. *C. auricilia*, *P. indicus* and *Bissetia steniellus* Hmpsn., are believed to have spread to new and far-off areas mainly through the seed material. Efforts were made to find out if borer larvae in seed-cane could be destroyed by soaking the cane in insecticidal solutions. Canes infested with *C. auricilia* were cut into 2 or 3 pieces each and soaked for 2 hours in different insecticidal liquids and also in water. 350 canes were used in each treatment. Mortality of larvae was recorded by splitting open the cane pieces after the treatment.

TABLE 65

Mortality among C. auricilia larvae within the cane as a result of soaking in different insecticidal liquids

Treatment (soaking for 2 hours)	Total number of larvae found in the canes	Number found dead	Per cent mortality
Endrin 0.1 per cent emulsion	103	103	100
Gamma BHC 0.1 -do-	142	125	88.0
DDT 0.1 -do-	140	88	62.9
Gamma BHC + DDT 0.1 per cent emulsion	103	101	98.1
BHC 0.1 per cent suspension	118	74	62.7
Basudin 0.1 per cent emulsion	88	85	96.6
Diazinon 0.1 -do-	111	82	73.9
W.L. 1650 (Telodrin) 0.1 per cent emulsion	132	123	93.2
Heptachlor 0.1 per cent emulsion	132	81	61.4
Dipterex 0.1 per cent solution	119	91	76.5
-do- 0.2 -do-	109	109	100
Water soaking	95	31	32.6
Control (no soaking)	97	1	1.1

High mortality among the larvae was observed with endrin, basudin and BHC + DDT all in 0.1 per cent emulsions and dipterex in 0.2 per cent solution.

The above insecticides having proved effective, further studies were undertaken to find out if these treatments had any adverse effect on germination. For this purpose two experiments were laid out, one a small scale trial with Co.S.510 in 8 sq.m. plots replicated 4 times, and the other a regular trial with Co.975 in 42 sq. m. plots replicated 6 times. The setts under both the experiments were soaked for 2 hours in the insecticidal liquids (and also in water) and then planted in the normal way after allowing them to dry in shade. Germination counts were started 4 weeks after planting.

TABLE 66

Effect of insecticidal soaking on germination of buds

Treatment (soaking)	Per cent germination of buds after — weeks				
	4	5	6	7	8
1	2	3	4	5	6
(a) Small-scale trial					
Endrin 0.1 per cent emulsion	0.2	2.0	6.6	12.0	17.3 (23.9)
Basudin -do-	2.1	3.8	12.5	23.9	28.7 (31.9)

recorded one month after treatment.

TABLE 64

Efficacy of bacterial spore powder (HB-III) of *B. cereus* var. *thuringiensis* (Berliner) against *C. auricilia* and *P. indicus*

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Basudin -do-	2.1	3.8	12.5	23.9	28.7 (31.9)

1	2	3	4	5	6
Gamma BHC + DDT 0.1 per cent emulsion (mixture)	nil	nil	0.8	2.4	5.3 (12.1)
Dipterex 0.2 per cent S.P.	0.4	3.2	19.3	37.2	43.6 (41.3)
Water	1.8	3.1	17.1	35.0	43.1 (41.0)
Control	2.3	2.0	22.9	24.9	33.3 (35.0)
LSD at 5 per cent level					4.934

(b) Main trial

Endrin 0.1 per cent emulsion	12.7	20.4	22.7 (28.3)	24.1	25.2 (29.9)
Basudin -do-	18.4	25.6	27.1 (31.3)	28.6	29.6 (32.9)
Gamma BHC + DDT 0.1 per cent (mixture)	1.6	5.3	7.1 (15.3)	7.9	8.5 (16.8)
Dipterex 0.2 per cent emulsion	28.6	35.4	37.2 (37.6)	38.1	38.3 (38.2)
Water	31.2	38.4	39.8 (39.1)	40.2	41.0 (39.8)
Control (no soaking)	28.7	38.0	40.1 (39.3)	41.2	42.4 (40.6)
LSD at 5 per cent level			3.510		2.874

N.B. Figures in parentheses are transformed into angle $\sin^{-1}\sqrt{\text{percentage}}$

While gamma BHC + DDT and endrin emulsions and to a lesser extent basudin had depressing effect on germination, dipterex 0.2 per cent solution compared favourably with water-soaking treatment and control.

4. Studies on chemical control of shoot borer, Chilotraea infuscatellus Snell.

i) Trials with systemic insecticides.- In a feeler trial, emulsions of different systemic insecticides were either sprayed on foliage or applied in the soil under the shoots at the time of borer activity in May. Ten affected clumps were taken as a unit for each treatment. After 10 days of treatment, all the shoots were uprooted and split open for recording mortality among the caterpillars.

TABLE 67

Mortality among shoot borer larvae as a result of treatment with different systemic insecticides

Treatment		Per cent mortality among shoot borer larvae under	
		soil application	foliar application
Phosdrin	0.1 per cent	58.3	28.6
Phosdrin	0.2 " "	66.7	80.0
Ekatin	0.1 " "	28.6	nil
Ekatin	0.2 " "	50.0	25.0
Metasystox	0.1 " "	nil	nil
Metasystox	0.2 " "	100.0	40.0
Isochlorothion	0.1 " "	60.0	25.0
Isochlorothion	0.2 " "	80.0	66.7
Control		nil	nil

Soil application of metasystox 0.2 per cent emulsion proved most effective against the pest. Foliar spray with phosdrin 0.2 per cent and soil application of isochlorothion 0.2 per cent also gave good results. However, the results can only be taken as an indication, as the number of borer-larvae per treatment was too small. for a conclusive result.

ii) Trials with chlorinated hydrocarbons and and other modern insecticides.- For these trials, an experiment was laid out with 10 treatments (Table 68) replicated 4 times, using Co.S.510 in plots with 200 sq. m. area. Insecticides were sprayed once in April and once in May. Observations were recorded before and one month after the spraying.

TABLE 68

Efficacy of chlorinated hydrocarbons and other modern insecticides against shoot borer, C. infuscatellus

Treatment	Before treatment		After treatment	
	Per cent incidence	Seizures per hectare	Per cent incidence	Seizures per hectare
1	2	3	4	5
Granular endrin at 13.5 kg. per hectare	9.4	10310	4.6(12.0)*	5827
Endrin 0.1 per cent emulsion	7.6	10759	13.5(21.1)	17336
W.L. 1650 (Telodrin) 0.1 per cent emulsion	4.0	8069	7.8(15.7)	11656
Trithion 0.1 per cent emulsion	6.6	8966	8.9(16.6)	10310
Sevin 0.5 per cent suspension	7.0	8966	14.7(22.3)	15689
Chlorocide 0.5 -do-	10.9	9413	10.5(17.7)	13449
Gusathion 0.1 per cent emulsion	8.9	12103	10.7(18.2)	15242

1	2	3	4	5
Gamma Cereclor 0.25 per cent suspension	7.9	9863	10.1(17.8)	11226
Dipterex 0.5 per cent solution	4.9	9413	12.9(19.9)	12553
Control (no treatment)	6.9	11656	22.4(26.9)	20622
LSD at 5 per cent level			7.8	

* The figures in parentheses are transformed into angles $\sin^{-1}\sqrt{\text{percentage}}$

All the treatments excepting sevin and dipterex were significantly better than control; 2 per cent granular endrin at 13.5 kg. per hectare gave the best results (Table 68).

5. Studies on parasites

i) Indigenous parasites .- Top borer, Scirpophaga nivella F. eggs were found parasitised at the Institute farm by Telenomus beneficiens Zhnt. during the pre-monsoon period. The per cent parasitisation ranged from 13 to 66.

Parasitisation of top borer larvae by Melcha ornatipennis Cam., Rhaconotus scirpophagae Wlk., Elasmus zehntneri Ferr. and Iphiaulax sp. was recorded. In August 1960, per cent parasitisation by these was 11.5, 19.2, 15.4 and 11.5, respectively. Thus a total of 57.6 per cent of the top borer larvae were found parasitised at that stage. Afterwards there was a steady decline in their activity and by end of October per cent total parasitisation came down to 14.6 only.

Efforts to rear M. ornatipennis and R. scirpophagae in the laboratory did not succeed.

Two consignments of Trichogramma evanescens minutum Riley were obtained from the Government Entomologist, Mysore with a view to breeding and multiplication of the parasite in the Institute Laboratory on its alternate host, Corcyra cephalonica Staint. for trials against the stalk borer, C. auricilia. This parasite had earlier been tried against the shoot borer, C. infuscatellus in the north Indian sugarcane areas but without much success, probably because of high maximum temperatures and low relative humidity prevailing in this region at the time of shoot borer activity. Since activity of the stalk borer, C. auricilia starts after the break of the monsoons, it was felt that Trichogramma might prove effective against this borer.

Quite a large percentage of Corcyra eggs were successfully parasitised in the laboratory by the adult wasps which emerged from the stock obtained from Mysore. But emergence of adults from this freshly parasitised stock in the Institute laboratory was very poor probably because of 'super-parasitism' which was observed to occur in almost all cases as revealed by examination of the parasitised Corcyra eggs. Field trials could not therefore be carried out.

ii) Exotic parasites.- Lixophaga diatraeae Tns., Metagonistylum minense Tns. and Paratheresia claripalpis Wulp, were imported into India from Trinidad by the Entomologist-Incharge, Station of the Commonwealth Institute of Biological Control, Bangalore under a Scheme of the Indian Central Sugarcane Committee. Out of these parasites only L. diatraeae could be easily reared on caterpillars of top borer, S. nivella under laboratory conditions. It was therefore decided to try this parasite under field conditions against different borer pests of sugarcane found in north Indian sugarcane areas. The Assistant Entomologist of the Institute was deputed to the Commonwealth Institute of Biological Control, Bangalore Station in September, 1960 for necessary observations on the parasite, and later in March, 1961, two consignments of the puparia of L. diatraeae (totalling 100) were obtained for study of the parasite under Lucknow conditions. The flies emerged from 61 puparia, but these did not survive for more than 48 hours in the laboratory where temperature ranged between 23 to 25°C and RH 50 to 70 per cent. No mating was observed among the flies and it was therefore not possible to breed and multiply the parasite.

6. Study of methods for assessing pest incidence and population

The methods of assessing incidence and population of C. auricilia are being worked out on the basis of data collected some time back from a field at the Institute farm. Tentative conclusions arrived at in this regard have already been reported in earlier reports.

Observations were recorded in December, 1960 in a field near Barabanki (Uttar Pradesh) with a view to finding out methods of assessing incidence of top borer, S. nivella which is a serious pest in Barabanki area. The size of the field selected for the purpose was about 500 sq. m. Attack of the pest was recorded brood-wise on individual stalks from clump to clump. About 70 per cent of the total canes in the field were found attacked.

The total number of clumps so examined was 1,397 with an average of 3.2 stalks per clump. The data are being scrutinised statistically for devising suitable methods for assessing top borer incidence on field scale.

7. Insect collection and identification

Periodic collection of different sugarcane pests as also casual insect visitors to sugarcane crops was continued through light traps at night and visits to the fields in day time. Fifteen new species of insects were added to the Institute collection. About a dozen species of insects collected at the Entomological Outpost, Tanjore were got identified through the courtesy of the Forest Research Institute, Dehradun.

8. Study of behaviour of new Co. varieties towards pest incidence

During the premonsoon period sixteen varieties namely, B.O.17, Co.449, Co.453, Co.785, Co.975, Co.997,

Co.1118, Co.1149, Co.1155, Co.1176, Co.1254, Co.1305, Co.1306, Co.1308, Co.1319 and Co.1321; Co.L.29; C.P.34/79 and C.P.49/50; Co.S.510, Co.S.541, Co.S.555 and Co.S.568, were examined for the incidence of shoot borer, C. infuscatellus. The seizures were recorded by counting the total number of 'deadhearts' in whole plots of 655 sq.m. each and the incidence was worked out on the basis of examination of all the shoots in two rows selected at random in each plot. The number of seizures varied from 2,139 in Co.1319 to 24,023 in B.O.17 per hectare, while the per cent incidence ranged from 0.65 in Co.1305 to 5.33 in Co.1233. In view of low incidence of the pest in all the varieties, it was not possible to assess the susceptibility or resistance of the different varieties to shoot borer attack.

9. Studies on the biology and control of white grub, Lachnosterna consanguinea Blanch.

These studies were continued till end of October, 1960 after which the Scheme was terminated.

i) Emergence of adults.- Sporadic emergence of beetles occurred in the first fortnight of June 1960, while the rush of emergence started on the 17th and 18th June after a few showers of rain. The numbers of beetles collected through light traps and from various food plants were 8,064 and 19,501 in June, and 2,890 and 11,831 in July.

ii) Varietal susceptibility.- The populations of grubs per hectare recorded in August in different varieties at the Bank Farm, Dalmianagar (Bihar) on the basis of examination of 5 per cent of the total row length were as follows: Co.527:9880; Co.617:15,808; Co.935:17,784; B.O.32: 12,844; B.O.34:11,856 and B.O.38:10,967. Co.935 showed the highest grub population.

iii) Control studies.- (a) Chemical control - A block trial for control of the grubs was laid out at the Bank Farm, Dalmianagar. On the basis of results obtained during 1959-60, two doses of BHC (dust) 5.6 kg. and 11.2 kg. actual per hectare, were applied. In one block, application of insecticide was done only once in June, while in the other it was done twice, in June and July respectively. Post-treatment observations were recorded in August by digging out, to a depth of 0.6 m., 3.4 m. row length at 5 places selected at random under each treatment.

TABLE 69

Efficacy of BHC dust against the grubs of L. consanguinea

Treatment	Application	Grub population per hectare (in August)	Per cent reduction against control
1	2	3	4
BHC at 5.6 kg. actual per hectare	(once in June only)	3,260	37.5

1	2	3	4
BHC at 11.2 kg. actual per hectare	(once in June only)	1,956	62.5
-do- 9.6 kg. -do-	(Twice, first in June and then in July)	2,608	50.0
-do- 11.2 kg. -do-	-do-	1,304	75.0
Control		5,217	

Two applications of BHC dust, each at 11.2 kg. actual per hectare gave the best results. These observations are in conformity with those recorded during 1959-60.

(b) Cultural control - Sweet sorghum was sown in the beginning of July 1960 in-between the cane rows to see if it could act as a bait crop for Lachnosterna grubs. On account of heavy rains, the germination of the crop was rather poor (40 per cent). Observations on white grub population were recorded in August by digging out the shoots from 5 per cent of the total row length, selected at random. In sweet sorghum the population was 2,964 per hectare as against 5,928 per hectare recorded in the adjoining sugarcane crop. No grubs were found attached to the sorghum roots. It was thus evident that sweet sorghum plants could not be utilised as a bait crop.

10. Miscellaneous

Insect Pests Co-ordination Scheme

Consolidated reports of the work done at different State centres under the co-ordinated Insect Pests Scheme financed by the Indian Central Sugarcane Committee during the year 1959-60 was prepared and submitted to the Secretary, Indian Central Sugarcane Committee.

SUGARBEET AGRONOMY

The project of experiments on sugarbeet cultivation was initiated in 1959-60 at the instance of the Ministry of Food and Agriculture, Government of India. The objective of the project was to ascertain the possibility of growing sugarbeet as a crop under Indian conditions. The first year's tests conducted at the Indian Institute of Sugarcane Research in 1959-60 having proved successful, the project was taken up on a wide scale in 1960-61 with a series of experiments at the Indian Institute of Sugarcane Research, Lucknow, and a co-ordinated system of experiments at sugarcane research stations in different parts of India. The work was carried out by the Agronomy section of the Indian Institute of Sugarcane Research.

During the year, seed of 4 varieties was procured from the U.S.A., of 2 from the Federal Republic of Germany, and of one from the U.S.S.R. In most cases, the seed reached this Institute in August and September 1960.

Due to unprecedented heavy rains in early October, sowings at Lucknow were done in late October and in November. Otherwise, the cropping conditions were good.

No major pests and diseases were observed on the crop, except a few cases of root rot; the affected plants were uprooted and destroyed to check the spread of the disease. The roots were lifted 6-7 months after sowing.

1. Trial of sugarbeet varieties

16 varieties namely Ero, Polyro, N.K.,* Cercopoly Polybeta, Interpolybeta, E.G., E, Z, ZZ, E.C.16688, Ramonskaya, U.S.22/3, US 35, US 75, and US-H2 were tested in 4 randomised blocks with a plot size of 81 sq. meters. The trial was sown on 13th November, 1960.

TABLE 70

Performance of sugarbeet varieties

Varieties	Yield of roots in metric tons per hectare	Number of roots in thousands per hectare	Average weight of roots in kg.	Sugarbeet per cent roots in			Sugar out put in metric tons per hectare
				March	April	May	
1	2	3	4	5	6	7	8
Ero	32.84	76.1	0.43	13.2	17.7	18.2	5.81
Polyro	29.33	81.3	0.36	14.9	19.0	18.8	5.58
N.K.	28.14	72.4	0.39	15.1	19.1	17.6	5.39
Cercopoly	86.91	66.2	0.41	14.8	18.7	18.2	5.04
Polybeta	27.65	55.6	0.50	14.2	17.4	17.8	4.82
Interpolybeta	18.93	27.4	0.69	13.3	16.5	20.6	3.11
E.G.	29.31	60.0	0.49	14.3	19.0	19.0	5.55
E	28.14	54.6	0.52	13.6	17.6	19.0	4.96

* A variety from East Germany: name not known at present.

1	2	3	4	5	6	7	8
Z	19.99	54.1	0.37	15.6	18.6	-	3.70
ZZ	19.87	66.9	0.30	16.9	19.2	-	3.80
E.C.16688	26.12	58.8	0.44	14.6	18.7	17.4	4.89
Ramonskaya	29.68	90.2	0.33	14.3	18.8	18.4	5.58
US 22/3	29.21	61.8	0.47	14.3	17.5	20.8	5.11
US 35	22.91	77.6	0.30	15.1	18.5	21.8	4.25
US 75	24.64	84.2	0.29	14.3	19.1	18.4	4.69
US-H_2	30.52	91.9	0.33	15.1	18.3	18.6	5.58
LSD	4.50						

The highest yield of beet roots was obtained with Ero (32.84 metric tons) followed by US-H2 (30.52 metric tons) and Ramonskaya (29.68 metric tons). The lowest yields were in ZZ and Z (20 metric tons) but these showed the best sugar content.

In the high-sugared varieties, ZZ, Z, US-H2, N.K., and US.35, the sugar content of roots in March was over 15 per cent, while the average of all the 16 varieties was 14.6 per cent. In the second week of April there was an improvement of about 3.8 units in the sugar content of the crop as a whole. In May, US.22/3, US.35 and Interpolybeta had about 21 per cent sugar.

2. Effect of time of sowing on sugarbeet

In order to find out the proper time of sowing sugarbeet in north India, an experiment with 3 dates of sowing, viz. 1st October, 15th October and 1st November was laid out in 6 randomised blocks with a plot-size of 81 sq. meters using variety US 22/3.

TABLE 71

Effect of date of sowing on the yield of sugarbeet

Date of sowing	Yield of roots in metric tons per hectare	No. of roots in thousands per hectare	Sugar per cent roots (March)
1st October	32.47	85.0	15.3
15th October	30.84	79.8	15.0
1st November	30.86	95.1	15.6
S.E. ±	0.60		

The 1st October sowing gave a slightly higher yield of roots than other two sowing dates. The quality of roots did not appear to differ due to dates of sowing (Table 71).

3. Effect of different methods of sowing and spacings on sugarbeet

Two methods of sowing, viz. ridge and flat, and 3 spacings, 38.1 cm., 45.7 cm., and 53.3 cm. (15, 18 and 21 inches) compared in 6 randomised blocks with a plot-size of 81 sq. meters, using variety US 75.

TABLE 72

Effect of method of sowing and spacings on yield and sugar content on sugarbeet

Treatment	Yield of roots in metric tons per hectare	Number of roots in thousands per hectare	Sugar per cent roots in March
Ridge sowing 38.1 cm. apart	34.10	141.3	14.3
Ridge sowing 45.7 cm. apart	31.60	123.0	14.8
Ridge sowing 53.3 cm. apart	31.65	104.2	14.8
Mean	32.47	122.8	14.6
Flat sowing 38.1 cm. apart	32.60	131.7	13.8
Flat sowing 45.7 cm. apart	31.73	112.6	14.5
Flat sowing 53.3 cm. apart	30.91	99.5	14.0
Mean	31.75	114.6	14.1
LSD	3.43		

The differences due to methods of sowing and spacings were narrow and non-significant (Table 72). However, sowing on ridges affords ease in the application of irrigation water and in lifting out the roots at harvest time; roots can be lifted out conveniently by means of a country plough.

Sowing on ridges showed 0.5 units higher sugar content than that on flat. Like sugarcane, sugarbeet also tends to show better sugar content under wider spacings.

4. Response of sugarbeet to irrigation and fertiliser

An experiment with three levels of nitrogen (0 kg., 56.1 kg. and 112.2 kg. per hectare) and two levels of irrigation (5 and 7 irrigations) was laid out in a split-plot design, with irrigation levels to main plots and nitrogen levels to sub-plots, in 4 replications with a plot-size of 110 sq. meters. Nitrogen was applied as ammonium sulphate at the time of sowing.

TABLE 73

Yield and sugar content of sugarbeet

Treatments per hectare	Yield of roots in metric tons per hectare	Number of roots in thousands per hectare	Sugar per cent roots
	5 Irrigations		
No nitrogen	16.51	58.1	15.7
56.1 kg. "	24.49	66.5	15.9
112.2 kg. "	26.69	49.9	13.1
	7 Irrigations		
No nitrogen	18.75	62.8	15.5
56.1 kg. "	24.81	57.8	15.3
112.2 kg."	29.97	66.7	14.8
	Main effects		
5 Irrigations	22.56	58.1	14.9
7 "	24.51	62.5	15.2
No nitrogen	17.64	60.5	15.6
56.1 kg. "	24.66	62.3	15.6
112.2 kg."	28.32	58.3	14.0
S.E. for irrigation levels	0.79		
LSD for nitrogen levels	2.00		

Application of 112.2 kg. nitrogen per hectare gave a significantly higher yield than 56.1 kg. and this in its turn, was significantly superior to the unmanured control (Table 73). 7 irrigations gave 1.95 metric tons per hectare more yield than 5 irrigations, but the difference was not significant.

The interaction between nitrogen levels and irrigations was not significant.

The higher dose of nitrogen depressed the quality of roots; irrigational treatments had no effect.

5. Response of phosphate to sugarbeet

With a view to finding out the response of sugarbeet to phosphate, an experiment was laid out on the paired-plot system in 4 replications with a plot-size of 110 sq. meters using variety US. 75.

TABLE 74

Effect of phosphate on the yield and sugar content of sugarbeet

Treatments	Yield of roots in metric tons per hectare	Number of roots in thousands per hectare	Sugar per cent roots in March
No phosphate	22.51	57.6	15.5
44.5 kg. P_2O_5 per hectare	23.62	57.3	15.2
S.E. ±	1.56		

Superphosphate at 44.5 kg. of P_2O_5 per hectare had no effect on the yield and quality of roots.

Studies on seed-setting in sugarbeet

A few plants of US 22/3 sown in October flowered in late March. There was however no seed-setting.

Co-ordinated Experiments on the Cultivation of Sugarbeet conducted in various parts of India 1960-61

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At the instance of the Ministry of Food and Agriculture, Government of India, a co-ordinated series of experiments was conducted in 1960-61 at the Indian Institute of Sugarcane Research, Lucknow and at Sugarcane Research Stations in various parts of India on the cultivation of sugarbeet, with a view to seeing whether the crop can be grown successfully in any part of India for the purpose of sugar manufacture. The seed required for these experiments was procured from the U.S.A., the U.S.S.R., West Germany and East Germany (vide page 99) A schedule of cultivation under Indian conditions and a standard method of determination of sugar content in roots were drawn up on the basis of the literature and information collected and the experience gained at the Institute earlier and these together with the proposed programme of experiments and the needed seed of sugarbeet varieties was supplied to the co-operating State Stations in September 1960. All the necessary information was provided and the work was co-ordinated by this Institute.

The programme consisted of a varietal trial, a trial on the method of sowing, and one on the time of sowing. The following sugarcane research stations participated in the project: Jullundur, Karnal, Muzaffarnagar, Shahjahanpur, Gorakhpur, Pusa and Mandya*. The programme covered an area of between 0.24 hectare at Mandya and 1.50 hectares at Lucknow.

In addition to these stations, each of the Sugarcane Research Stations/Farms at Anakapalle, Bhopal, Bhubneshwar, Burdwan, Dabra, Durgapur, Gangawati, Kanpur, Kota, ~~and~~ Sankeshwar, were supplied with a few grams of seed each for conducting preliminary cropping tests on a small scale; at these centres the acreage put under beet was less than 0.06 hectare. A small quantity of seed was also supplied to Messrs Parry and Co. and tried by them at Samalkot, Pugalur and Ooty.

Due to late rains in October at many of the places, the sowing of the crop was delayed upto November. The seed-rate varied from 5.61 to 11.22 kg. per hectare. The cropping schedule drawn up at this Institute was followed at most of the Stations with minor variations where necessary, and apparently, no difficulties were experienced in raising the crop. The crop however, is believed to have received much care at all the stations during this first year. The number of irrigations given varied from 2 at Pusa and 5 at Lucknow to about 30 at Mandya. It was given about 112.2 kg. of nitrogen and between 44.5 and 89 kg. of P_2O_5 per hectare. Apart from delayed sowings in some places, the cropping conditions in most cases were reported to be satisfactory and the crop behaved well at all the major stations (except at Gorakhpur where it was damaged due to borers, etc.), and also

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* Results obtained at the Indian Institute of Sugarcane Research, Lucknow are also incorporated mutatis mutandis in this report in order to provide a complete account.

at all the small-test stations (except Anakapalle, Bhubaneshwar and Burdwan). Roots were dug up at the end of the crop-duration of between 150 days at Mandya and 230 days at Jullundur, the harvest being mostly between the last week of April and the end of May.

Results

1. Trial of sugarbeet varieties

7 varieties were included in replicated, randomised block trials at 8 centres. The results of 7 trials (omitting those of Gorakhpur) are given in table 75.

TABLE 75

Mean yields of roots of sugarbeet varieties in varietal trials conducted at 7 centres in India

Yields in metric tons per hectare (and sugar per cent root in parentheses)

	Jullundur	Karnal	Muzaffarnagar	Shahjahanpur	Lucknow	Pusa	Mandya	Mean
Ero	38.30 (16.0)	56.71 (12.5)	37.14 (15.4)	35.53 (13.6)	32.84 (17.7)	61.48 (14.7)	24.96 (11.4)	40.99 (14.5)
Polyro	28.00 (16.7)	48.14 (14.7)	34.89 (15.5)	29.78 (14.3)	29.33 (19.0)	70.60 (13.0)	22.73 (11.6)	37.63 (15.0)
N.K.	31.55 (16.4)	49.91 (14.7)	37.73 (15.6)	23.70 (15.2)	28.14 (19.1)	63.73 (15.0)	24.71 (13.4)	37.07 (15.6)
US 22/3	34.62 (15.9)	43.91 (15.8)	36.13 (15.6)	26.79 (14.9)	29.21 (17.5)	63.28 (15.1)	23.23 (12.4)	36.74 (15.3)
US 35	29.03 (16.6)	36.30 (15.3)	34.30 (15.0)	27.16 (15.5)	22.91 (18.5)	69.98 (14.7)	20.76 (12.7)	34.35 (15.5)
US 75	31.23 (16.4)	42.01 (15.2)	34.30 (16.0)	29.21 (15.6)	24.64 (19.1)	73.64 (15.0)	19.03 (11.3)	36.25 (15.5)
Ramonskaya	36.25 (16.1)	50.41 (15.5)	38.35 (16.0)	35.53 (15.4)	29.68 (18.8)	71.19 (15.4)	21.00 (11.4)	40.35 (15.5)
Mean	32.71 (16.3)	46.77 (14.8)	36.12 (15.6)	29.67 (14.9)	28.10 (18.5)	67.71 (14.7)	22.34 (12.0)	37.63 (15.3)

The results were remarkably consistent, the comparative out-turn as between the 7 varieties being more or less the same at all the centres. The mean yields of varieties ranged from about 41 metric tons of roots per hectare in Ero and 40.35 metric tons in Ramonskaya to 36.25 and 34.35 metric tons per hectare in US.75 and US. 35 respectively. The other three varieties gave about 37 metric tons on the average.

The highest yields were recorded at the Pusa Station (67.71 metric tons per hectare) and the lowest were at Mandya, where considerable difficulty seems to have been experienced in establishing the crop.

The sugar content was also determined at all the above centres. The quality was the highest at Lucknow being

on the average 18.5 per cent sugar on roots, whereas at Mandya where the roots had presumably to be lifted a little prematurely, it was the lowest (12.0 per cent). The average for all the centres and all the varieties was 15.3 per cent for the north Indian Stations alone. This indicates a sugar out-turn of 12 to 13 per cent on roots.

As between varieties, averaged over the 7 centres, the sugar content ranged between 14.5 and 15.6 per cent. The ~~three~~ varieties N.K. (East Germany) Ramonskaya (U.S.S.R.), ~~and~~ US 75 and JS 35 (U.S.A.) topped the list.

2. Trial on the suitable time of sowing sugarbeet

This trial in the co-ordinated series was conducted at 6 centres. The suggested treatments were, sowing on (i) 1st October, (ii) 15th October and (iii) 1st November; however, the actual dates varied to some extent at the various centres. US. 22/3 was used for this experiment.

The results (Table 76) showed that earlier sowings were better than later sowings, the mean increase due to a fortnight's earliness of sowing being about 5 metric tons per hectare. In sugar content there was on the whole no difference due to the time of sowing.

TABLE 76

Effect of time of sowing on yield and sugar content of sugarbeet roots

Yields in metric tons per hectare (and sugar per cent root in parentheses)

	Jullundur	Karnal	Muzaffarnagar	Shahjahanpur	Lucknow	Pusa	Mandya	Mean
1st October	38.72 (14.5)	51.84 (15.3)	27.03 (15.0)	40.01 (13.4)	32.47 (15.3)	67.85 (16.2)	-	42.99 (14.9)
15th October	33.75 (14.5)	50.88 (15.6)	24.39 (14.7)	23.43 (13.6)	30.84 (15.0)	60.59 (16.7)	-	37.31 (15.0)
1st November	23.80 (14.4)	41.66 (15.8)	23.20 (14.6)	20.26 (13.9)	30.86 (15.6)	56.88 (16.0)	-	32.77 (15.0)

3. Trial on method of sowing sugarbeet

Results for this trial were received from 7 centres. The treatments were i) sowing on ridges about 15 cm. high, against ii) sowing on flat. The spacing between rows was 46 cm. and the variety used US.75.

The results (Table 77) indicated that sowing on ridges was better by about 3.83 metric tons per hectare.

TABLE 77

Effect of method of sowing on yield and sugar content of sugarbeet roots

Yields in metric tons per hectare (and sugar per cent root in parentheses)

	Jullundur	Karnal	Muzaffarnagar	Shahjahanpur	Lucknow	Pusa	Mandya	Mean
On ridges	38.70 (15.8)	44.60 (14.9)	18.53 (14.5)	20.46 (13.2)	32.44 (14.6)	39.24 (16.2)	27.68 (-)	31.55 (14.9)
On flat	31.97 (15.2)	39.98 (15.2)	14.36 (14.6)	20.26 (14.2)	31.75 (14.1)	29.75 (15.8)	25.95 (-)	27.72 (14.9)

In addition to the above field experiments, small-scale varietal tests with 7 varieties were conducted at 7 other centres, viz. Anakapalle, Bhopal, Bhubaneshwar, Gangawati, Kota, Sankeshwar and Sehore. The results from these largely confirmed those from the full-scale trials, Ero and Ramonskaya being the top-yielders on the average and US.75 having the best quality roots.

General observations

Suitability of the crop.- The overall results showed that the crop can be successfully grown in many parts of India. The results were particularly promising in north-western and northern India, and also in north-central India; for the last-mentioned area and for most parts of south India, however, data were available only from small-scale tests.

Field behaviour of the crop

Most centres reported that there was no serious damage of any kind from diseases and pests on the crop. There were attacks by one or more of the following: cut-worms, hairy caterpillars, grass-hoppers, borers, beetles, beetle-grubs, nematodes, root-rot, and leaf-spot, but the damage was of a minor order and attack was either transient or quickly controlled. Only at Gorakhpur, about 50 per cent of the plants were reported to have been damaged by root-rot and a common moth-borer. A few cases of leaf-yellowing and crown-gall occurred at Jullundur. Anakapalle reported considerable loss due to leaf-spot, root-rot, beetles and grasshoppers. Damage due to grubs and nematodes was noticed at Mandya and Sankeshwar. The plants raised at Smalkot by Messrs Parry and Co. were attacked by a disease which was later diagnosed at the Indian Institute of Sugar-cane Research, Lucknow, as "Charcoal rot".

Yield of roots and sugar content

The average yield of roots at the 7 major centres ranged between 22.3 metric tons at Mandya and about 46.8 metric tons per hectare at Karnal. In individual varieties and treatments, yields as high as 56.8 tons or more per hectare were obtained.

The sugar content of roots varied on the average between 12.0 per cent at Mandya to 18.5 per cent at Lucknow. On the whole, it appears that a sugar content can well reach about 15-16 per cent on roots at the end of 6-7 months' growth. A standard method of estimation of sugar was circulated to all the stations but this being the first year of the work, the data requires further confirmation.

Disposal of crop

Since sugarbeet roots do not yield any juice as sugarcane does, and equipment for extraction by diffusion is not available at any of the sugar mills, the disposal of roots at the experiment stations was somewhat problematical. Following the practice resorted to in the course of the establishment of the sugarbeet industry in West Pakistan, a suggestion was made to major participants of the project that roots may be disposed of at the nearest sugarcane factory by mixing them with the bulk of sugarcane raw material going into the crushers. This appears to have been successfully done in most of the places, although the full extraction of sugar could not possibly have been achieved by this method. The tops were fed to cattle in some cases, but mostly they were either turned into the field, or composted.

Cost of cultivation and crop suitability

The cost of cultivation was roughly estimated at between Rs.864.85 and Rs.1482.60 per hectare. At Lucknow the cost was earlier estimated at Rs.840.14 per hectare (Rs.340 per acre).

All the Stations except Gorakhpur, Anakapalle, Bhubaneshwar and Burdwan reported that the crop is suitable for cultivation in their areas and can be grown successfully. Some of the Stations indicated a bright future for the crop under their conditions and thought that the proposition was likely to be economic on a commercial scale. All the Stations (except Anakapalle) asked for seed for the 1961-62 season.

Extraction of sugar - The crop at Lucknow was reserved for the purpose of technological tests on extraction of sugar at the National Sugar Institute, Kanpur, where slicing machines and diffusers for extraction of sugar had been designed and installed. 36.6 metric tons of fresh roots were supplied to the unit, about 3 tons each time, lifted from the field over a preceding period of 12 to 24 hours, washed, weighed and loaded in a truck.

Seed-setting - A part of the crop at the co-operating Stations was suggested to be left in the field beyond May in order to see if any of the varieties would set flowers and produce seed. At Karnal, Lucknow and Pusa some plants of US.22/3 bolted (produced flowers-spikes). At Karnal a few seeds were also collected and these were found to be viable.

Acknowledgements - The successful conduct of the project during the first year has been largely due to

the full co-operation rendered by the participating Stations. The cost of raising the crops at the State Stations was incurred by the Stations themselves. Apart from the actual results of the trials, many valuable observations were reported from Karnal. Thanks are also due to the TCM of U.S.A. and the Embassy of the U.S.S.R; to Messrs Gebrüder Dippe, Herford, West Germany and Kleinwanzlebener Saatzucht, Einbeck, West Germany, Dr. H. O. Warner and Dr. R.M. Hill, University of Nebraska, Dr. R.S. Loomis of the University of California and Dr. Dewey Stewart, Leader, Sugarbeet Investigations, U.S. D.A., for kindly supply the seed of sugarbeet/for furnishing information on the various aspects of sugarbeet cultivation.

TECHNICAL PROGRAMME FOR 1961-62

Agronomy

1. Germination studies.

   i) Effects of keeping and treating setts with Aretan.

   ii) Effects of application of Aretan on different portions of cane sett.

   iii) Effect of soil compaction.

2. Studies on tillering.

   i) Plant density in relation to seed-rate.

   ii) Effect of plant density on tillering and cane-formation.

3. Cultural studies.

   i) Studies on absolute spatial relationships of cane clumps.

   ii) Studies in the control of weeds.

      a) On the comparative efficiency of certain herbicides.

      b) On the effect of Dowpon at different stages of crop growth.

   iii) Effect of mulches.

4. Studies on water conservation.

   On economising irrigation water.

5. Fertilisers and manures.

   i) Comparison of nitrophosphate manufactured by O.D.D.A. and P.E.C. processes at different levels and by different methods of application.

   ii) Comparative efficiency of certain inorganic fertilisers for sugarcane.

6. Varietal work.

   i) Seedlings.
   ii) Preliminary test of seedling varieties.
   iii) Final test plot.
   iv) Trial of promising varieties.
   v) Receipt of varieties.
   vi) Despatch of new Co. canes.
   vii) Live herbarium.

Agricultural Chemistry and Soil Science

1. Comparative cumulative effects of manures and chemical fertilisers on sugarcane crop and soils.

2. Studies on modus operandi of green manure.

3. Soil-plant relationship of potassium in sugarcane soils of India.

4. Nutritional studies on sugarcane.

5. Studies on nitrogen transformation in sugarcane soils.

Physiology

1. Studies on the prevention of flowering.

2. Studies on germination.

3. Biochemical basis of resistance to red rot.

Agricultural Engineering

1. Study and improvement of agricultural implements at present used for sugarcane cultivation in different regions.

2. Field testing of sugarcane implements designed and manufactured in the country by private agencies or imported from abroad.

3. Designing and fabricating improved bullock-drawn and tractor-drawn implements and other machinery for sugarcane cultivation.

4. Devising ways and means of conserving irrigation water.

5. Exploring possibilities of overhead irrigation for sugarcane.

6. Mechanisation of sugarcane cultivation.

7. Collaborative conduct of long-term experiments on important cultural operations.

Mycology

1. Studies on the nature of red rot resistance in sugarcane.

2. Assessment of the comparative reaction of sugarcane varieties to red rot infection, by plug and nodal methods of inoculations.

3. Comparative behaviour of varieties in relation to the life-cycle of cane and biotypes of the red rot pathogen.

4. Assessment of comparative response of sugarcane varieties to smut infection, by artificial inoculation.

5. Studies on physiologic specialisation in smut organism.

6. Assessment of losses in yield due to mosaic.

7. Observations on twisted top and albino diseases.

8. Studies on the plant parasitic nematodes.

Entomology

1. Studies on toxicity of different insecticides in relation to major sugarcane pests.

2. Studies on some promising parasites of sugarcane pests.

3. Study of methods for assessing pest incidence and populations.

4. Classification and maintenance of sugarcane insect fauna.

5. Studies on biology and control of stalk borer, Chilotraea auricilia Ddgn.

6. Study of behaviour of new Co. varieties towards pest incidence.

7. Preparation of critical reviews of Entomological work in and outside India and of survey maps relating to the distribution and the intensity of attack of different cane pests in India.

Sugarbeet

1. Trial of sugarbeet varieties.

2. Trial on nitrogenous fertiliser requirements of sugarbeet.

3. Trial on the irrigational requirements of sugarbeet.

4. Studies on seed production.

5. Studies on transplanting of sugarbeet seedlings.

6. Co-ordinated trials on sugarbeet cultivation at various centres in India.

i) Varietal trial.
ii) Dosage of nitrogen.
iii) Irrigation experiment.
iv) Studies on seed production.

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9. Kalra, A.N. — Top borer of sugarcane and its control through aerial spraying with endrin; Sugarcane Herald, 1960.

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Appendix I

Equivalents in metric and other units.

1 inch	....	=	2.54 centimetres
1 centimetre	....	=	0.394 inches
1 foot	....	=	0.305 metre
1 metre	....	=	3.281 feet
1 acre	....	=	0.405 hectare
1 hectare	....	=	2.471 acres
1 seer	....	=	0.933 kilogram
1 kilogram	....	=	1.072 seers
1 maund	....	=	37.324 kilograms
1 maund	....	=	0.373 quintal
1 quintal (100 kilograms)	....	=	2.679 maunds
1 metric ton (10 quintals)	....	=	26.792 maunds
1 maund per acre	....	=	0.092 metric ton per hectare
1 gallon	....	=	4.546 litres
1 litre	....	=	0.220 gallon
1 mile	....	=	1.609 kilometres
1 mile per gallon	....	=	0.354 kilometre per litre
1 kilometre per litre	....	=	2.825 miles per gallon

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A N N U A L R E P O R T

O F T H E

SCHEMES FINANCED BY THE INDIAN CENTRAL SUGARCANE COMMITTEE

A T T H E

INDIAN INSTITUTE OF SUGARCANE RESEARCH

LUCKNOW

1960-61

1. All India co-ordinated Scheme for the Investigation and Control of Rust Disease of Sugarcane.

2. Entomological Outposts Scheme.

3. Scheme for studies of Physical and Chemical Criteria of Gur leading to the formulation of the Basis of Gur Grades.

4. Scheme for Studies in Storage of Gur.

All India co-ordinated Scheme for the Investigation and Control of Rust Disease of Sugarcane - Indian Institute of Sugarcane Research, Lucknow.

Objective - Studies on rust disease of sugarcane with special reference to its control.

Finance and details of implementation

The scheme was wholly financed by the Indian Central Sugarcane Committee. The budget grant of the scheme for the year under report was Rs.21,000, the revised estimate Rs.14,000 and the total expenditure Rs.12,736.

Staff - The following sanctioned staff in the scheme continued to be working during 1960-61.

Assistant Mycologist	(Class II) ...	One
Fieldmen ...	... (Rs.80-110 revised) ...	Two
Mali ...	... (Rs.70-85 revised) ...	Two

Shri M.M. Tiwari was the Assistant Mycologist from November 21, 1959. The investigations were carried out under the guidance of Dr. Kishan Singh, Mycologist.

Technical programme of work 1960-61

1. Testing the efficacy of fungicides for direct control of rust.
2. Standardisation of technique for adult resistance tests.
3. Search for collateral hosts.
4. Screening of varieties for rust resistance.

Non-technical summary - In field experiments for chemical control laid out in Lakhimpur-Kheri area, natural incidence of rust was itself low and marked differences in treatment effect could not be obtained. The efficacy of Ferbam and Ziram was however indicated. Lethal doses of nine fungicides were determined in the laboratory. The excised-leaf technique was further modified and perfected. Differences in varietal reaction were obtained through this technique. Rust naturally occurring on *Saccharum spontaneum* at Lucknow and that occurring on *Erianthus fulvus* in Simla hills were found capable of infecting sugarcane. Co.290, Co.419, Co.684 and Co.S.510 in field experiments and Co.419, Co.S.321, Co.S.416 and Co.S.510 in laboratory experiments proved to be susceptible. Rust cultures could be successfully maintained on leaf-pieces of adult plants throughout the year (25 generations) and on potted plants.

Detailed report -

1. Testing the efficacy of fungicides for control of rust -

(a) In the field: The experiment for the chemical control of sugarcane rust was repeated at Jamnabad farm in Lakhimpur-Kheri district of U.P. The experiment was carried out with only one variety Co.S.510 with its ratoon and planted crops, using 10 fungicidal treatments including the un-

treated check, replicated 4 times.

The fungicides tested this year and their dosage were:- wettable sulphur 2000 g., Thiovit (80 per cent wettable sulphur) 2000 g., Spersul (water dispersible sulphur powder) 2000 g., Ferbam (75-76 per cent ferric dimethyl-dithiocarbamate) 1500 g., Ziram (zinc dimethyl-dithiocarbamate) 1500 g., Shell copper fungicide (50 per cent copper oxychloride) 2500 g., Fytolan (copper oxychloride) 2500 g., Thiram (Tetra-methyl thiuram disulphide) 1500 g., and Flit 406 (N-trichloromethyl thio-tetra hydrophthalamide) 1000 g., per 1000 litres of water (100 g. per litre is equivalent to 1 lb. per gallon).

The chemicals were sprayed on the crop on 16th December 1960 and 17th January, 14th February, 24th March and 14th April 1961 with a foot sprayer at the rate of 2,245 litres per hectare per application. (1 hectare = 2.47 acres). In the experimental plots, the first incidence of rust was recorded in March, 1961 on Co.S.510 ratoon.

The observations on rust incidence and intensity were recorded each time before spraying. Spraying was not done at the time of final observations in May, 1961. During December 1960, and January, February and May 1961 the intensity of rust was only slight and the incidence negligible. The disease did not appear at all in the plant crop. Data are therefore given in the table only for the ratoon crop, and that also only for March and April 1961.

TABLE 1

Efficacy of fungicides in the control of sugarcane rust

Fungicides	Per cent infection on shoot basis		
	March	April	
Wettable sulphur	11.6	6.9	
Thiovit	21.6	10.5	
Spersul	7.2	7.9	
Ferbam	9.1	4.7	
Ziram	5.1	7.2	
Thiram	12.5	6.8	
Shell copper fungicide	13.8	8.2	
Fytolan	10.1	8.9	
*Flit 406	13.0	12.9	*Spraying was done in March, 1961
Control	20.6	13.4	

Due to low incidence, treatment differences were not as striking as those observed last year. However, the efficacy of Ferbam, Ziram and Spersul is indicated, confirming last year's results.

(b) In the laboratory: This experiment was carried out for determining the efficacy of the various fungicides against germination of rust uredospores. Fungi-

cides in various concentrations were incorporated in 4 per cent agar medium. Freshly obtained uredospores were applied on the surface of the solidified medium with a sterilized camel hair brush. The germination of the spores and the length of germ tubes were recorded 5 hours after seeding.

The minimum lethal doses thus determined for wettable sulphur, Thiovit, Spersul, Ferbam, Ziram, Agallol, Hexasan, Ceresan and Fytolan were 1, 0.1, 1, 0.1, 1, 1, .01, 0.1 and 1 per cent respectively.

2. Standardisation of technique for adult resistance tests - The cut-leaf technique initiated in 1959-60 was slightly modified in respect of temperature and lighting. The inoculum was applied as uredospore suspension in sterile distilled water with a sterilized brush on 4-inch pieces of excised leaves of a test variety, which (pieces) were maintained in Petri-dishes. Leaves of different varieties were inoculated by this technique for comparative reaction to rust.

The resistance of the young potted plants was also tested. The results were compared with those obtained by inoculating adult plants in the field. Co.419 and Co.S.510 gave susceptible reaction by all the three methods. These methods will be tested on a large number of varieties this year.

3. Search for collateral hosts - Rust of sugarcane was used to inoculate the leaves of a number of grasses by the cut-leaf technique. It failed to infect Saccharum spontaneum (Lucknow), Erianthus munja, Arundo donax, Pennisetum purpureum, E. arundinaceus (SES 7, SES 17, SES 27, SES 89 and SES 347) and S. spontaneum (SES 267); resistant reaction was obtained in case of E. arundinaceus (SES 79 and SES 136), E. arundinaeus (Coimbatore) and E. elephantinus (SES 369).

Rust naturally occurring on S. spontaneum around Lucknow and on E. fulvus in Simla hills was found capable of infecting the leaves of sugarcane Co.S.510.

Rust from E. munja and A. donax failed to form pustules on the leaves of sugarcane Co.S.510. E. munja rust inoculated on Co.S.510 produced brown dots with yellow zones around. Histopathological studies revealed that there was no pustule formation; however plugging of parenchymatous cells and xylem vessels of leaf by a brownish-red gummy substance was observed.

4. Screening of varieties for rust resistance - (a) Adult resistance trial in the field: Co.290, Co.312, Co.313, Co.419, Co.421, Co.449, Co.453, Co.469, Co.513, Co.527, Co.605, Co.617, Co.684, Co.975, Co.997, Co.1111, Co.1209, Co.K.32, Co.L.29, Co.S.321, Co.S.416, Co.S.443, Co.S.510, Co.S.514, Co.S.515, Red Mauritius, B.O.3, B.O.10, B.O.11, B.O.13 and B.O.14 were inoculated on 24th and 25th November, 7th, 19th and 22nd December 1960 and 13th January 1961 in the field. The rust pustules developed well on Co.290, Co.419, Co.684 and Co.S.510 indicating their sus-

ceptibility to rust disease. On the inoculated leaves of Co.312, Co.313, Co.421, Co.449, Co.453 and Co.617 brown dots with yellow zones around were observed at the places of inoculation. The remaining varieties remained free from infection.

(b) Adult resistance trial in the laboratory (cut-leaf technique).- Pieces of leaves of fully-grown plants were inoculated by the cut-leaf technique. 25 varieties Co.290, Co.312, Co.313, Co.419, Co.421, Co.449, Co.453, Co.469, Co.513, Co.527, Co.605, Co.617, Co.684, Co.975, Co.997, Co.1111, Co.1209, Co.K.32, Co.S.321, Co.S.416, Co.S.443, Co.S.510, Co.S.514, Co.S.515 and Red Mauritius were thus tested. Of these, pustules were formed only on Co.419, Co.S.321, Co.S.416 and Co.S.510 while brown dots with yellow zones were formed in Co.312, Co.469 and Co.527.

(c) Resistance trial in the laboratory (potted plant technique) .- Young potted plants of Co.290, Co.312, Co.313, Co.419, Co.421, Co.453, Co.527, Co.605, Co.617, Co.684, Co.975, Co.997, Co.1111, Co.1209 and Co.S.510 were inoculated with fresh uredospore inoculum maintained on Co.S.510. Pustules were formed only on Co.290, Co.419 and Co.S.510.

5. Maintenance of Rust cultures: Rust cultures were maintained on cut leaves (25th generation) and potted plants of Co.S.510 throughout the year. The cultures are still going.

6. Miscellaneous - Studies on the survival of sugarcane rust in the plains: Certain tests were made to determine how long the uredospores of sugarcane rust remain viable in nature, and for how long the spores can withstand the high summer temperatures. It was observed that the uredospores remained viable upto the first week of May, 1961. There was no viability on 12th May 1961.

Technical programme 1961-62

1. Testing the efficacy of fungicides for direct control of rust.

2. Standardisation of technique for adult resistance tests.

3. Search for collateral hosts.

4. Screening of varieties for rust resistance.

Publications:

Two papers entitled "Maintenance of Rust Cultures" and "Chemical Control of Sugarcane Rust" have been sent for publication in Indian Journal of Sugarcane Research and Development.

R.R. Panje,
DIRECTOR.

Entomological Outposts Scheme

Indian Institute of Sugarcane Research, Lucknow

Objective

The aim of the Entomological Outposts Scheme is to survey the different areas for the occurrence of sugarcane pests, to study biology of major pests, and to gather information on the influence of weather and climatic conditions on their incidence and population.

Studies of this type have been in progress for the past many years in the Punjab, Uttar Pradesh, Bihar, West Bengal, Andhra Pradesh, Bombay and Madras. But in certain other States like Rajasthan, Madhya Pradesh, Assam and Orissa, such work had not been taken up till 1958. The Indian Central Sugarcane Committee therefore sanctioned in 1958, the establishment of 5 Entomological Outposts, one each for Rajasthan, Madhya Pradesh, Orissa, Assam and the Tanjore area of Madras.

Finance and details of implementation

The scheme was implemented in 1959-60 and 4 Entomological Outposts, viz. at Sriganganagar (Rajasthan), Sehore (Madhya Pradesh), Koothanallur in Tanjore district (Madras) and Rayagada (Orissa) were established under the Indian Institute of Sugarcane Research, Lucknow. The establishment of the 5th Outpost in Assam has been in abeyance at first due to the inability of the selected candidates to join there, and now because of a cut in the sanctioned budget of the Scheme during the 3rd Plan.

Total budget sanctioned for the scheme for 1960-61 was Rs.90,000 out of which Rs.48,091 was utilised. The Scheme is at present sanctioned upto 28th February 1962. The Scheme is financed wholly by the Indian Central Sugarcane Committee.

Staff - The staff at each Outpost comprises one Senior Research Assistant, one Research Assistant, one Field Attendant and one Laboratory Attendant. The names of the personnel on the Scheme in 1960-61 are given below.

Sriganganagar.-

Senior Research Assistant	-	Shri G.S. Vilkhu.
Research Assistant	-	Shri N.C. Sharma.

Sehore.-

Senior Research Assistant	-	Vacant.
Research Assistant	-	Shri J.P. Rathore.

Koothanallur.-

Senior Research Assistant	-	Shri H. David.
Research Assistant	-	Shri K. Ananthanarayana.

Rayagada.-

Senior Research Assistant - Shri C.P. Dutta.
Research Assistant - Shri D.K. Banerji. (joined on November 9, 1960).

The technical guidance to the staff was provided by the Entomologist, Indian Institute of Sugarcane Research, who is the Officer-in-Charge of the Scheme.

Technical programme of work 1960-61

1. Influence of individual weather conditions, (cloudiness, rain, humidity etc.) and general climatic conditions, on the incidence and population of borers, Pyrilla and white-fly infesting sugarcane.

2. Biology of sugarcane pests.

3. Survey of cane pests.

4. Collection of insect fauna visiting sugarcane during the crop season.

Summary

At Sriganganagar, top borer, Scirpophaga nivella F. became active with the on-set of rains in July, reaching its maximum activity in August-September. The shoot borer, Chilotraea infuscatellus Snell. remained active from April to October; its highest population was recorded in the first fortnight of July. During later stages, it damaged internodes also. The activity of the root borer, Emmalocera depressella Swinh. also started in the premonsoon period and steadily increased till the first fortnight of September. Incidence of Pyrilla perpusilla Wlk. and white-fly, Aleurolobus barodensis Mask. was negligible in the crop under observation.

The period of activity of the top borer and shoot borer was March to October; each pest passed through 5 broods in the year.

Sugarcane crops in Sriganganagar, Kota and Udaipur zones were surveyed.

At Sehore, the shoot borer, C. infuscatellus was active during the premonsoon period, but its population was low as a whole. Top borer and Pyrilla became active in June, and their populations were highest during the monsoon and post-monsoon periods.

Studies on the biology of top borer and shoot borer were carried out.

Sugarcane crops in Sehore, Betul and Hoshangabad areas were surveyed.

At Rayagada, the incidence of top borer was negligible during the crop season. Shoot borer, C. infuscatellus was most active during the premonsoon period. The inci-

dence of white-fly was highest in the second fortnight of September.

Observations on the life history of shoot borer were made in the laboratory.

The sugarcane crops in Koraput, Sambalpur, Bolangir, Ganjam and Sundergarh districts were surveyed.

Trials on the chemical control of termites, which is a serious pest in Nayagada area, were conducted.

At Koothanallur in Tanjore district, the incidence of top borer was observed from May to December. The maximum population of the pest was recorded in first half of October. The shoot borer was most active during the premonsoon period. The activity of internode borer, Proceras indicus Kapur was observed from end of June till harvest. The maximum population of the pest was recorded in mid-October.

Studies on biology of internode borer, P. indicus and the pink borer, Sesamia inferens Wlk. were carried out.

The sugarcane crops in Tanjore, Trichy and Salem districts of Madras, and of the Pamba River Factory area in Kerala State were surveyed.

Detailed report -

1. Influence of individual weather conditions and general climatic conditions on the population of borers, Pyrilla and white-fly.

Observations on different pests were recorded at all the Outposts according to the standard method followed under the Co-ordinated Insect Pests Scheme. The progressive populations of different species of borers along with the maximum and minimum atmospheric temperatures, mean RH and rainfall as recorded at the different Outposts have been shown in figures 1 to 4. The maximum activity of the pests against the meteorological data for the corresponding periods, are summarised in table 1.

One of the findings on the climatological relationships was that the top borer, which is usually active under moderate maximum temperatures and high RH conditions, was able to multiply at Sriganganagar during August-September, even though the maximum temperatures were comparatively high and the mean RH rather low. Another observation was that at Sriganganagar, the shoot borer, unlike in the adjoining States of Punjab, U.P. and Madhya Pradesh, remained active till as late as October; this was apparently because of the favourable climatic conditions during the monsoon and post-monsoon periods. The root borer, internode borer, Pyrilla and white-fly did not show any marked difference in their behaviour in relation to climatic conditions from what had been observed earlier at various centres under the Insect Pests Scheme.

2. Biology of sugarcane pests

Studies on the biology of top borer and shoot

Fig.1 Climatic conditions in relation to borer population (Sriganganagar) 1960-61

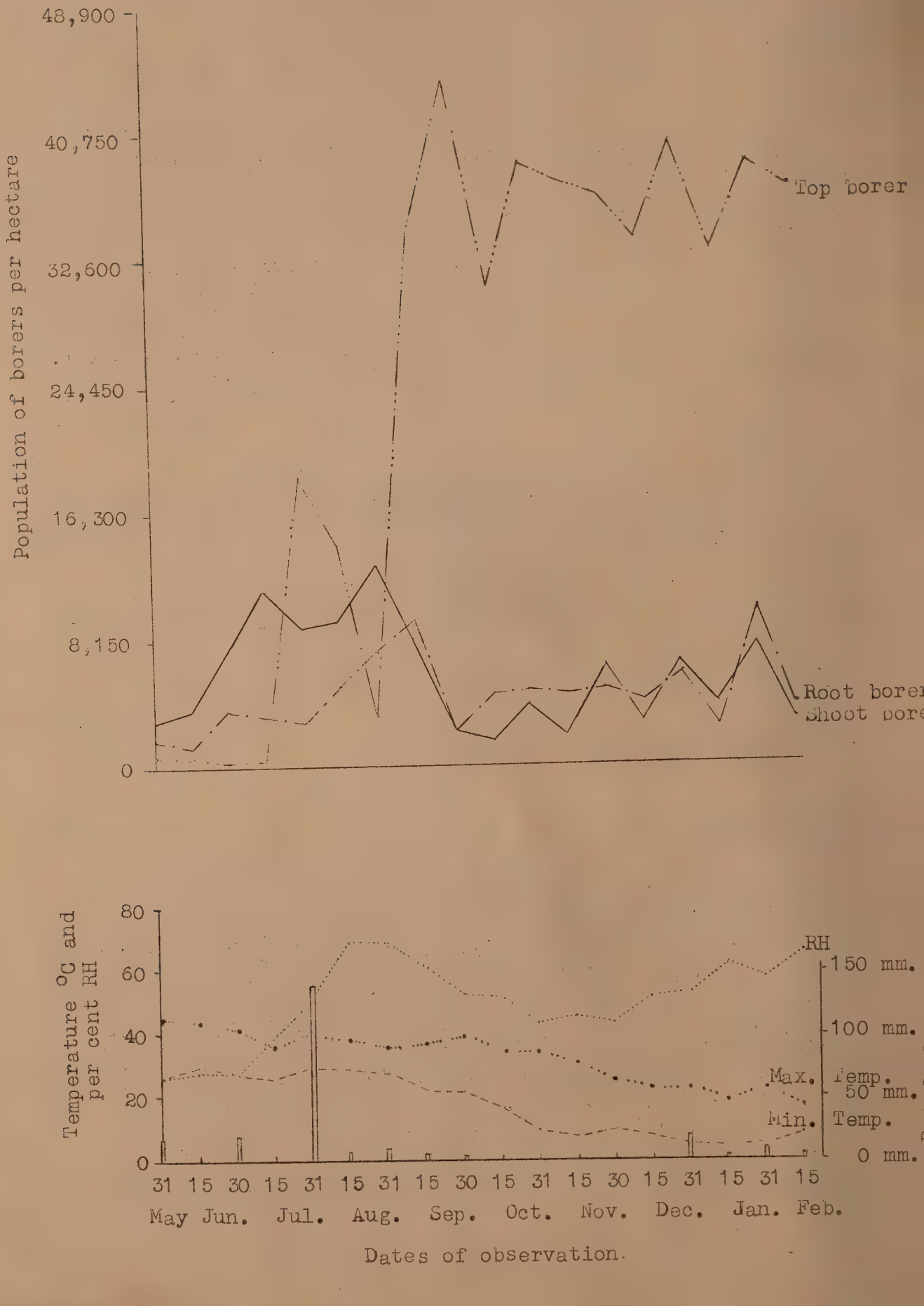


Fig.2 Climatic conditions in relation to borer population (Sehore) 1960-61

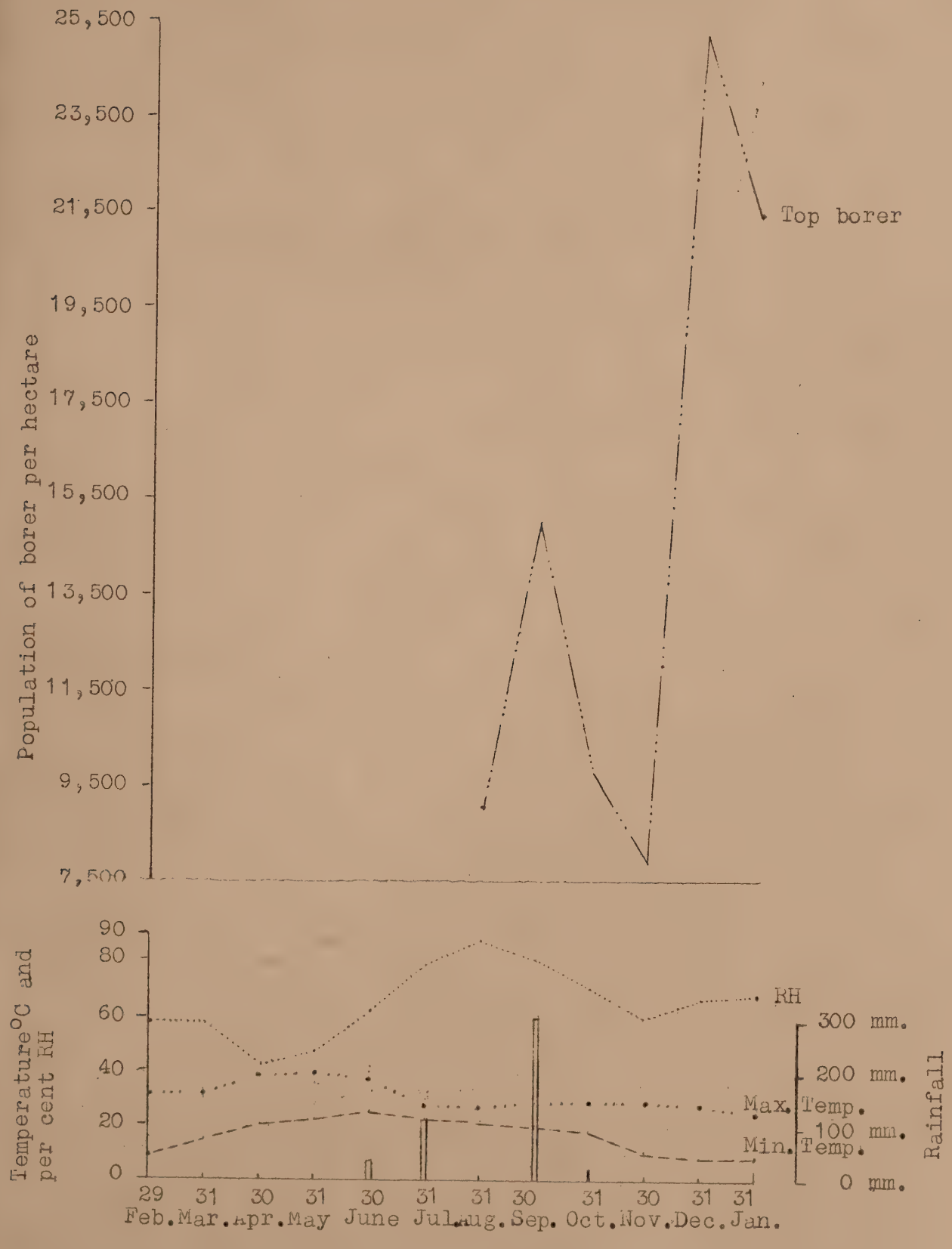


Fig.3 Climatic conditions in relation to borer population (Rayagada) 1960-61

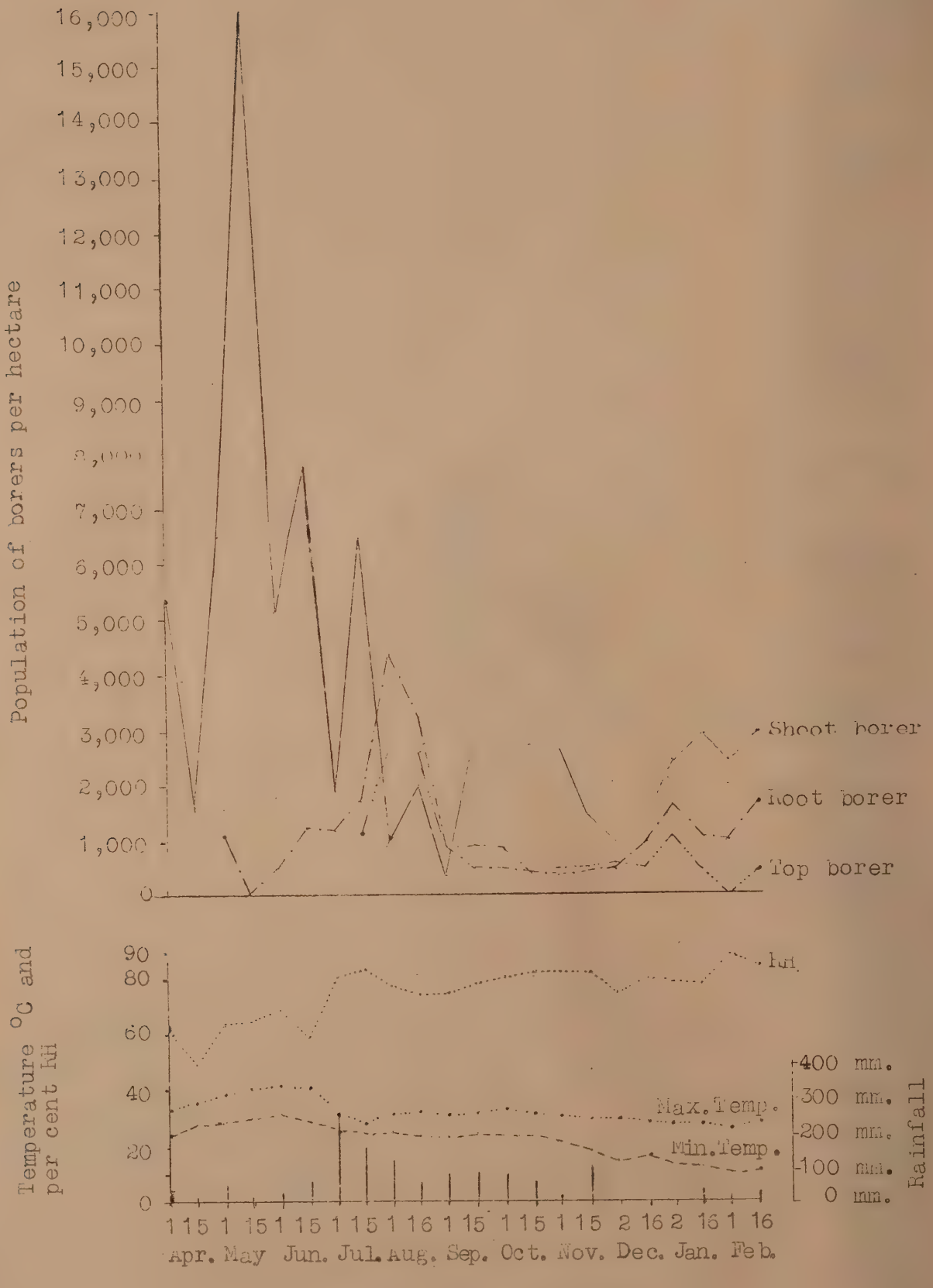


Fig.4 Climatic conditions in relation to borer population (Koothanallur) 1960-61

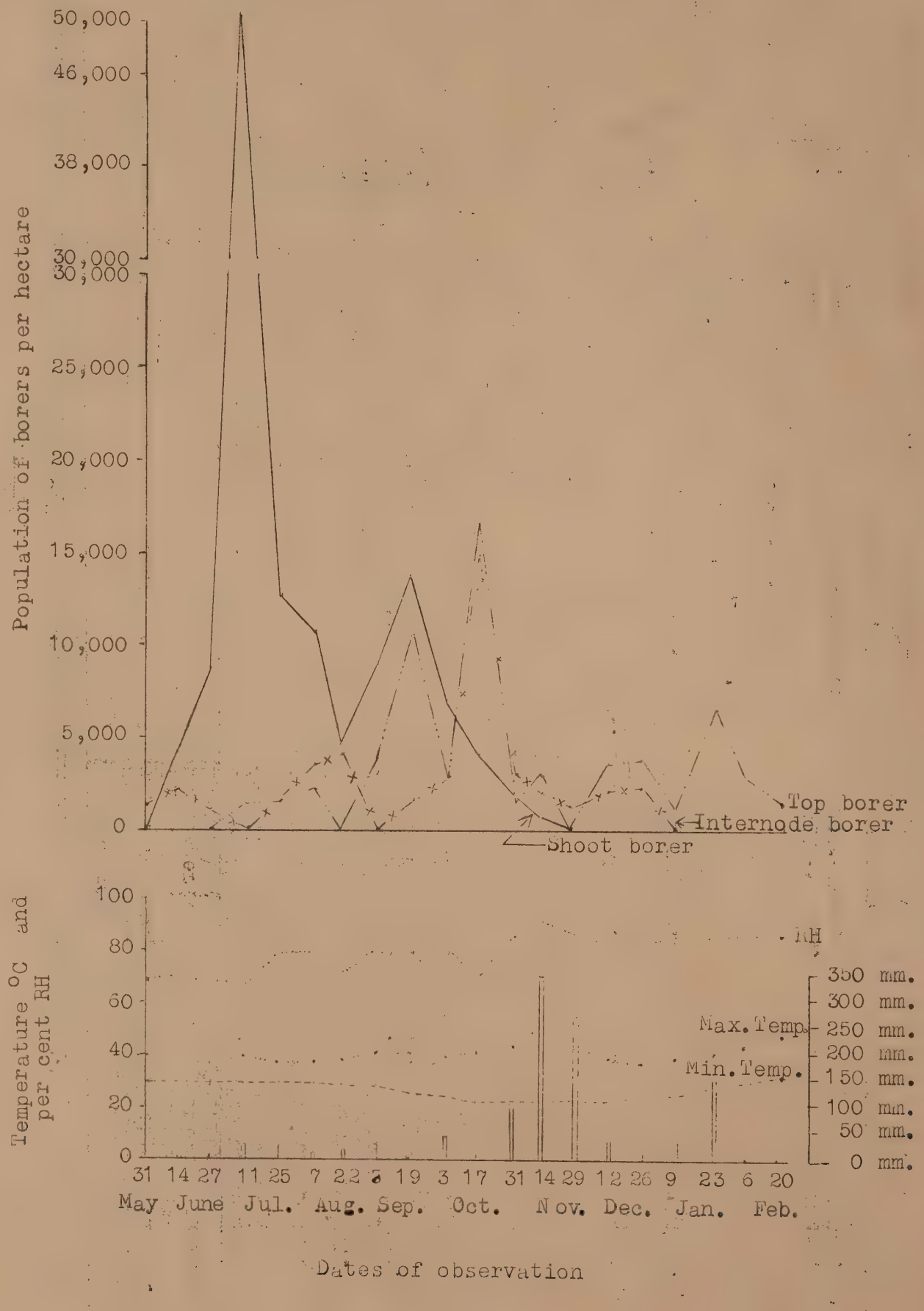


TABLE 1

Populations of various pests in relation to temperature, humidity, rainfall, etc.

Outpost		Variety	Period of maximum activity	Maximum population (larvae and pupae) per hectare	Mean maximum temperature °C (during the period of maximum activity	Mean relative humidity	Rainfall in mm.
Top borer, S. nivella	Sriganganagar	Co.312	1st week of August to end-September.	44,550	36.5 to 38.7	53 to 69	21.6
	Sehore	Co.421	Mid-June to mid-July.	24,617	29.2 to 32.7	82 to 90	126.0
	Rayagada	Co.419	Population low throughout.	16,672	32.9 to 34.1	69 to 79	45.0
	Koothanallur	Co.419	1st week of July to 3rd week of October.	11,412	36.5 to 42.0	28 to 69	37.5
Shoot borer, C. infuscatellus	Sriganganagar	Co.312	Mid-June to mid-September.	6,600	27.3 to 39.5	44 to 62	26.0
	Sehore	Co.421	1st week of May to end-June.	16,302	38.5 to 40.6	54 to 59	148.7
	Rayagada	Co.419	1st week of April to mid-May.	50,759	37.4 to 40.0	60 to 66	5.0
	Koothanallur	Co.419	Mid-June to mid-July.	9,374	36.5 to 42.0	28 to 69	39.1
Root borer, E. depressella	Sriganganagar	Co.312	Mid-June to end-September.				
	Sehore		Population low throughout.				
	Rayagada		-do-				
	Koothanallur		No attack met with.				
Internode borer, P. indicus	Sriganganagar		No attack met with.				
	Sehore						
	Rayagada						
	Koothanallur	Co.419	3rd week of Sept. to 3rd week of Oct.	14,820	37.4 to 39.0	69 to 80	11.0
Pyrilla, P. perpusilla	Sriganganagar	Co.312	Population negligible.	1,857*	29.3 to 31.0	62 to 90	110.00
	Sehore	Co.421	1st week of July to mid-August.				
	Rayagada		Population low throughout.				
	Koothanallur						
White-fly, A. barodensis	Sriganganagar		Population low throughout.				
	Sehore		-do-				
	Rayagada	Co.419	Mid-July to end-September.	642**	34.4 to 37.8	70 to 85	345.9
	Koothanallur	Co.419	1st week of October to mid-November	540**	33.0 to 38.0	82 to 95	440.0

* Nymphs and adults per unit of 20 leaves.

** Nymphs and puparia per unit leaf area of 30 sq. cm. over 10 leaves.

borer were carried out at Sriganganagar and at Sehore, shoot borer at Rayagada and internode borer at Koothanallur.

Sriganganagar

Top borer, S. nivella - The borer passed through 5 generations during the year. The successive generations started in the 3rd week of March, 2nd week of May, 1st week of July, 3rd week of August and the last week of September, respectively. The durations of these generations were approximately 10 weeks, 10 weeks, 7 to 8 weeks, 7 weeks, and 24 weeks, respectively with slight overlappings. The 5th brood larvae remained under hibernation from mid-October to mid-February and the moths from these began to emerge in mid-March.

Shoot borer, C. infuscatellus - This borer also completed 5 broods during the year. The successive broods started in the 3rd week of March, 2nd week of May, 4th week of June, 1st week of August and 4th week of September respectively. Their durations were about 10, 9, 6 to 7, 9 and 24 weeks respectively with slight overlappings. The caterpillars of the 5th brood remained under hibernation from about mid-October to mid-February and their moths began to emerge in the 2nd week of March.

Sehore

Top borer, S. nivella - The pest passed through 5 broods during the year, the 1st brood starting from the 3rd week of February and the succeeding ones from 3rd week of April, 2nd week of June, 1st week of August and 3rd week of September, respectively. The durations of the 5 broods were about 10, 8, 9, 9 and 22 weeks respectively with slight overlappings. The larvae of the 5th brood remained under hibernation from/October to end of January. During July-August the duration of egg, larval and pupal stages was 6 to 10 days, 20 to 40 days and 6 to 10 days, respectively.

/mid-

Shoot borer, C. infuscatellus - Life history of this borer was studied upto its 2nd brood. First brood lasted from 2nd week of March to 3rd week of May and the 2nd from 2nd week of May to 1st week of July. Each of these two broods completed its life cycle in 40 to 48 days.

Rayagada

Efforts were made to study life history of shoot borer, C. infuscatellus. On account of high mortality of larvae in the laboratory, detailed studies on this were not possible. It was observed that pupal stage of the pest lasted 5 to 8 days during April to June when average maximum temperature ranged between 34.3°C to 39.6°C and mean RH 56 to 73 per cent. It lasted 7 to 9 days during August to October when average maximum temperature came down to 31.9°C to 33.1°C and mean RH increased to 75 to 80 per cent.

Koothanallur

Internode borer, P. indicus - The adult moths emerged during the early hours of the morning. The females are bigger than the males and are extremely sluggish. Mating generally took place in the early hours of the morning.

Oviposition: The eggs were laid in clusters on the leaves, either on the mid-rib or on the lamina on the upper or lower surface. These were white in colour when freshly laid, but subsequently turned brown. The number of eggs per cluster varied from 8 to 28.

Larva: The eggs hatched in 5 to 6 days. The newly emerged larvae are light orange in colour with a black head and prominent thoracic shield. The young larvae fed gregariously under the tender leaf-sheaths. When partially grown up they entered the shoots or the stalks separately in each case.

The grown-up larvae were found to be migratory in habit transferring themselves from one internode or cane to the other.

The larval period lasted 46 to 48 days during September to November when average maximum temperature ranged between 32.5°C to 38.3°C and mean RH 62 to 90 per cent.

Pupa: The larvae when fully grown abandoned their burrows and came out of the canes. They wove small whitish silken cocoons within the folds of the leaf-sheaths in which they later pupated. The pupae were light brown when fresh, but later they turned dark brown. The pupal stage lasted 9 to 12 days.

The longevity of moths under laboratory conditions was 5 to 7 days.

The pink borer, S. inferens - The moths generally emerged between 7 p.m. and 10 p.m. The female moths after mating laid eggs in clusters on the inner surface of the leaf sheaths and in some cases on the soil surface also. The egg, larval and pupal stages lasted 5-7 days, 32-35 days and 7-9 days, respectively during May-June when the average maximum temperature ranged between 35.6°C and 40.0°C, the minimum temperature 28.7°C to 30.1°C and mean RH 62 to 66 per cent. One life-cycle was completed in 44-51 days in the laboratory during this period. The activity of the pest declined after June.

3. Survey of sugarcane pests

Rajasthan

The survey was carried out in Sriganganagar, Udaipur and Kota zones (Table 2). Top borer was recorded as a serious pest with 73 per cent incidence at Karanpur (Sriganganagar) and 38 per cent at Rajnagar (Udaipur) in the post monsoon period. Shoot borer though normally a hot-weather pest of the young shoots, attacked the crop all

through the crop season in Sriganganagar district with upto 81 per cent infestation on stalk basis. Post-monsoon attack (about 15 per cent) in the internodes was recorded in Bundi district of Kota zone also. The attack of the root borer was serious with 42 per cent post-monsoon incidence at Raisinghnagar (Sriganganagar) and 22 per cent at Rajnagar (Udaipur). Attack of Pyrilla was sporadic in all the districts while that of whitefly was serious in Kota and Bundi districts; mild infestation of mealy bug, Saccharicoccus sacchari Ckll. was also recorded in these two districts. Termite attack was as high as 25 per cent on stalk basis during the post-monsoon at Raisinghnagar. A few shoots attacked with Gurdaspur borer, Bissetia steniellus Hmpsn. were met with at Sriganganagar.

TABLE 2

Survey of sugarcane pests (Rajasthan)

Locality	Period of observation	Crop	Per cent incidence (on shoot/stalk basis)				Whitefly (Av. popl. per sq. cm. leaf area)
			Top borer	Shoot borer	Root borer	Termite	
Sriganganagar district	Premonsoon	Plant	Nil	4.2	Nil	2.1	Nil
		Ratoon	Nil	0.2	"	Nil	"
	Monsoon	Plant	13.9	5.11	0.9	1.4	"
		Ratoon	16.2	0.5	1.8	Nil	"
	Postmonsoon	Plant	23.8	42.4	Nil	6.2	"
		Ratoon	32.5	7.0	0.7	1.5	"
	Harvest	Plant	35.6	42.4	7.4	Nil	"
		Ratoon	45.0	13.4	1.2	"	"
Karanpur	Premonsoon	Plant	0.7	7.4	0.3	1.1	"
	Monsoon	Plant	17.8	27.3	Nil	Nil	"
	Postmonsoon	Plant	39.5	20.4	"	13.0	"
	Harvest	Plant	72.7	60.9	5.8	10.5	"
Raisinghnagar	Premonsoon	Plant	3.0	14.3	Nil	0.2	"
		Ratoon	0.5	11.6	0.2	3.3	"
	Monsoon	Plant	3.9	37.2	Nil	Nil	"
		Ratoon	4.3	30.3	24.2	"	"
	Postmonsoon	Plant	43.0	47.7	42.0	25.0	"
		Ratoon	18.5	52.5	81.0	8.9	"
	Harvest	Plant	35.7	81.0	42.5	5.7	"
Udaipur zone							
Rajnagar	Monsoon	Plant	38.0	16.9	9.3	Nil	"
		Ratoon	35.7	25.5	22.2	"	"
Kelwar	-do-	Plant	25.4	21.1	18.6	"	"
		Ratoon	20.4	8.5	10.8	"	"
Kota district							
Borkhera	Postmonsoon	Plant	8.8	2.0	Nil	"	17
Kunehera	-do-	-do-	15.5	4.8	"	2.3	12
Bundi district							
Jameelpura	-do-	Plant	57.5	6.6	"	Nil	"
		Ratoon	66.5	1.8	"	Nil	8
Dugai	-do-	Plant	33.9	1.1	"	"	6

Madhya Pradesh

Surveys were carried out in Sehore, Hoshangabad and Betul districts.

TABLE 3

Survey of sugarcane pests (Madhya Pradesh)

Locality	Period of observation	Crop	Per cent incidence on shoot/stalk basis				Pyrilla (av. popl. of adult & nymphs per leaf)	Whitefly (av. popl. of nymphs & puparia per sq. cm. leaf area)
			Top borer	Shoot borer	Pink borer	Root borer		
Sehore district								
Sehore	Premonsoon	Plant	-	4.0	7.0	20.0	-	-
		Ratoon	17.0	-	-	-	-	-
	Monsoon	Plant	21.0	2.5	-	3.0	8	-
		Ratoon	40.0	-	-	-	-	-
	Postmonsoon	Plant	75.0	3.2	10.0	2.5	15	9
		Ratoon	45.2	-	-	-	-	-
	Harvest	Plant	70.9	2.4	12.6	6.5	4	4
		Ratoon	45.7					
Hoshangabad district								
Powaikheda	Premonsoon	Plant		13.0	2.0	-	-	-
		Ratoon		21.3	8.0	-	-	-
Bankheri	-do-	Plant		42.5	-	5.5	-	-
		Ratoon		42.7	-	-	-	-
Betul district								
Betul Agricultural Farm	Premonsoon	Plant		15.5	-	5.0	-	-
	-do-	Ratoon		27.0	-	-	-	-

Top borer attack was serious in Sehore area (upto 75 per cent) in the postmonsoon. Shoot borer was serious in the premonsoon period in all the cane areas surveyed, being heaviest (42 per cent) in Hoshangabad district in June. Root borer attack was low in all the areas except in Sehore district where upto 20 per cent incidence was recorded in shoots in the pre-monsoon season. Attack of the pink borer, S. inferens was also observed in Sehore district. Serious infestation of Pyrilla was recorded in Sehore area in the post-monsoon period. Damage by termites was recorded in ratoon crop of Co.312 in Bankheri block in Hoshangabad district during the pre-monsoon period.

Orissa

Surveys were carried out in Koraput, Sambalpur, Bolangir, Sundergarh and Ganjam districts.

TABLE 4

Survey of sugarcane pests (Orissa)

Locality	Period of observation	Crop	Per cent incidence (on shoot/stalk basis)					Pyrilla (av. popl. of adults & nymphs per leaf)	Whitefly (av.popl. of nymphs & puparia per sq. cm. leaf area)
			Top borer	Shoot borer	Root borer	Termite	Mealy bug		
Koraput district									
Amlabhatta	Pre-monsoon	Plant	1.7	18.4	1.9	10.6	0.5	Nil	0.3
		Ratoon	1.0	25.9	2.3	8.4	2.8	"	0.4
	Monsoon	Plant	2.8	8.7	1.2	7.6	9.8	6	1.9
		Ratoon	1.6	3.6	9	5.2	6.3	15	0.5
	Post-monsoon	Plant	Nil	Nil	Nil	Nil	Nil	Nil	Nil
		Ratoon	2.3	10.4	1.3	16.0	"	"	"
	Harvest	Plant	Nil	Nil	Nil	Nil	Nil	Nil	"
		Ratoon	1.6	11.2	4.2	16.0	"	"	"
Raniguda	Pre-monsoon	Plant	1.3	22.1	2.6	17.1	12.5	"	0.3
		Ratoon	1.8	14.1	2.4	5.6	9.1	"	0.8
	Monsoon	Plant	3.2	7.7	7.3	8.9	6.5	"	1.4
		Ratoon	3.0	9.3	6.3	1.0	10.3	"	2.2
	Post-monsoon	Plant	1.6	11.6	10.7	22.7	5.0	"	0.8
		Ratoon	2.7	14.5	16.4	28.6	5.5	"	1.0
	Harvest	Plant	Nil	Nil	Nil	Nil	Nil	"	Nil
		Ratoon	0.8	13.2	8.4	12.0	5.2	"	2.3
Balianimma	Pre-monsoon	Plant	1.1	17.3	2.0	10.2	Nil	"	Nil
		Ratoon	1.4	16.1	3.0	10.2	1.6	"	0.5
	Monsoon	Plant	2.1	3.5	7.0	8.8	2.8	15	7.5
		Ratoon	0.7	2.8	1.4	Nil	Nil	31	1.4
	Post-monsoon	Plant	1.8	7.5	4.4	8.1	5.3	Nil	1.9
		Ratoon	0.8	9.3	13.8	8.1	0.8	Nil	1.0
	Harvest	Plant	0.8	9.2	6.2	11.8	3.8	"	2.2
		Ratoon	Nil	Nil	Nil	Nil	Nil	"	Nil
Sambalpur district									
Attavira	Post-monsoon	Plant	25.3	36.7	-	6.2	7.8	16	17.0
Bolangir distt.									
Sakma	-do-	Plant	6.0	15.6	-	5.0	6.2	22	17.2
Sundergarh distt.									
Kandabahal	-do-	Plant	3.7	19.7	-	4.7	4.4	17	10.6
Ganjam district									
Aska	Harvest	Plant	10.0	30.0	15.0	20.0	5.0	Nil	4.0

Top borer attack was low except at Attavira in Sambhalpur district where the maximum attack was 25 per cent only during the post-monsoon period. Heavy shoot borer attack was met with in all the areas in the pre-monsoon period. It ranged between 25 and 37 per cent at Amlabhatta in Koraput district, Aska in Ganjam district and Attavira in Sambalpur district. Root borer attack though low in the premonsoon and monsoon, was fairly serious in the postmonsoon period in Koraput and Ganjam districts. There were heavy attacks of termites and mealy bug at Rayagada during the premonsoon and post-monsoon periods. Pyrilla was observed in the monsoon and post-monsoon periods in Koraput, Sambalpur, Bolangir and Sundergarh districts. Its attack was high at Amlabhatta and Balianimma in Koraput district during September-October. Whitefly was recorded in Sambalpur and Koraput zones in the post-monsoon period. The attack was severe in areas where water stagnated after the rains.

Madras

Tanjore, Trichy and Salem districts in Madras State were surveyed (Table 5). Top borer attack upto 25 per cent was met with in Tanjore and Trichy districts; it was low in the other areas surveyed. Shoot borer attack was serious in Tanjore, Mayanur and Panangattangudi in April to June. Attack of the internode borer, P. indicus was met with in post-monsoon period in all the areas surveyed, with infestation upto 42 per cent in Tanjore district. Mild incidence of the pink borer, S. inferens/and scale insect, Aspidiotus glomerata Green was recorded in Koothanallur area of Tanjore district. Attack of the aphids, Longiunguis sacchari Zhnt. and L. indosacchari Zhnt. was also observed in a field at Koothanallur in November, 1960. Whitefly incidence was heavy in some fields in Tanjore area in the post-monsoon period while Neomaskellia bergii Signet was found infesting the cane crop in North Arcot district in July. Pyrilla and mealy bug were observed in Tanjore and Trichy districts.

The cane area of the Pamba River Sugar Factory in Kerala State was also surveyed in April, 1961. Pest incidence was observed to be extremely low except for a mild infestation of mealy bug, S. sacchari in some fields.

TABLE 5

Survey of sugarcane pests (Madras)

Locality	Period of observation	Crop	Per cent incidence (on shoot/stalk basis)			Whitefly (av.popl. per sq.cm. leaf area)
			Top borer	Shoot borer	Internode borer	
1	2	3	4	5	6	7
Tanjore district						
Thorakudi	Summer	Plant	Nil	22.1	Nil	Nil
		Ratoon	"	10.8	"	"
	Premonsoon	Plant	3.0	0.7	4.9	"
		Ratoon	0.9	0.4	4.5	"
	Monsoon	Plant	2.3	Nil	11.6	"
		Ratoon	5.1	"	6.1	"
	Postmonsoon	Plant	3.0	"	17.0	"
		Ratoon			12.0	"

1	2	3	4	5	6	7
Mayanur	Summer	Plant	Nil	54.7	Nil	Nil
		Ratoon	"	20.5	"	"
	Premonsoon	Plant	2.2	4.9	3.8	"
		Ratoon	2.8	4.0	5.4	"
	Monsoon	Plant	0.6		3.8	"
		Ratoon	6.5		6.5	"
	Postmonsoon	Plant	1.6		4.4	"
		Ratoon	6.4		10.2	"
Sattangudi	Summer	Plant	Nil	13.2		"
		Ratoon	"	14.8		"
	Premonsoon	Plant	"	2.2	1.9	"
		Ratoon	"	2.8	0.1	"
	Monsoon	Plant	2.7	Nil	7.0	"
		Ratoon	0.7	"	4.5	"
	Postmonsoon	Plant			17.4	"
		Ratoon	7.7	"	10.8	"
Panangattangudi	Summer	Plant	Nil	56.9		"
		Ratoon	"	17.6		"
	Premonsoon	Plant	1.0	5.5	2.9	"
		Ratoon	Nil	19.2	0.7	"
	Monsoon	Plant	2.1	Nil	0.7	"
		Ratoon	6.6	2.0	2.0	"
	Postmonsoon	Plant	2.6	Nil	4.7	"
		Ratoon	3.4	"	4.1	"
Rajapayyanchavadi	Monsoon	Plant	16.7	""	41.7	2.5
		Ratoon	25.0	"	37.3	2.0
Trichy district						
Pugalur	Premonsoon	Plant	22.0	11.6	15	Nil
		Ratoon	6.0	Nil	Nil	"
Salem district						
Omaber	Monsoon	Plant	Nil	Nil	13.4	"
		Ratoon	"	"	14.4	"

As a result of surveys conducted by the Outposts staff following broad conclusions can be drawn in respect of the areas so far surveyed.

i) Top borer occurs in serious form in almost all the cane tracts except in Rayagada area of Orissa.

ii) Shoot borer also is prevalent in the young crop in all the areas. It damages the internodes of grown-up canes also in Sriganganagar and Kota areas of Rajasthan.

iii) The internode borer, P. indicus is serious only in Madras State and has not so far been recorded as a pest from the other three States.

iv) Attack of the root borer is met with in a

serious form in certain areas in Rajasthan. In other States its incidence is low.

v) Mild attack of the pink borer, S. inferens was recorded in Sehore district (Madhya Pradesh) and at Koothanallur in Tanjore district of Madras.

vi) A few shoots attacked with Gurdaspur borer, B. steniellus, were found at the Government Agriculture Farm, Sriganganagar (Rajasthan).

vii) Termite attack is serious in Koraput district of Orissa, the Sriganganagar area of Rajasthan and in the Hoshangabad area in Madhya Pradesh.

viii) Sporadic attacks of Pyrilla and whitefly are met with in all the areas so far surveyed. Infestation by mealy bug is prevalent in Kota and Bundi zones of Rajasthan and Koraput district of Orissa.

4. Collection of insect fauna visiting sugarcane crop

Sriganganagar

An unidentified species of coccid and a beetle grub were collected from Udaipur area during the monsoon period. A few shoots infested with Gurdaspur borer, Bissetia steniellus Hmpsn. which is a serious pest of sugarcane originally in the Punjab and now also of Western Uttar Pradesh, were met with at the Government Agriculture Farm, Sriganganagar in Co.L.29 during July-August. Some caterpillars of the pink borer, S. inferens, were also collected from the young cane crop at the farm, in the pre-monsoon period.

Sehore

The mealy bug, Icerya pilosa nardi Green and the army worm, Leucania unipuncta Haw. were collected in the sugarcane crop at Gwalior during the pre-monsoon period. A species of grasshopper was collected at Sehore.

Rayagada

Unidentified species of a beetle grub and a grasshopper were collected at Rayagada. Mild infestation of an aphid sp. was also recorded. A few larvae of the internode borer, P. indicus which is a serious pest of sugarcane in Madras, were collected from the crop at Rayagada.

Koothanallur (Tanjore)

Mild attack of the blister mite, Aceria sp. was met with on young crop of Co.419. A species of an isopod identified as Philoscia sacchari N.sp. was found attacking the germinating buds under the soil surface. Other insects collected from Tanjore area were Leucania unipuncta Haw., Cyrtacanthacris sp., Nezara viridula L., and Chaphalocrocis medinalis Guen.

In the course of the studies on different pests and the insect fauna of the sugarcane crop, observations

were also recorded on the natural enemies of sugarcane pests.

Sriganganagar

Two species of parasites, Melcha sp. and Stenobracon sp. were recorded on top borer. The parasitisation in both cases was 1 to 2 per cent only. An egg parasite of Pyrilla was also observed.

Sehore

Melcha ornatipennis Cam., Elasmus zehntneri Ferr. and Rhaconotus scirpophagae Wlk. were recorded parasitising top borer in Sehore area. Parasitisation by M. ornatipennis was as high as 40 per cent in some of the fields. In the case of the other parasites, it was upto 2 per cent only. The egg parasite Telenomus beneficiens Zhnt. was also recorded on top borer. Heavy parasitisation by the green fungus Metarrhizium anisopliae Metch. was observed on the adults and nymphs of Pyrilla during August-September.

Rayagada

An unidentified dipterous parasite was recorded on the shoot borer. Parasitisation of pupae of whitefly, A. barodensis by Amitus aleurolobi Mani was also recorded. Tetrastichus pyrillae Crwf. was observed parasitising Pyrilla eggs.

Tanjore

Parasitisation by Telenomus beneficiens Zhnt. and Tetrastichus sp. on the eggs of top borer, and by Trichogramma evanescens minutum Riley on P. indicus eggs was recorded. Stenobracon deesae Cam., S. nicevillei Bing., Rhaconotus roslinensis Ltd., E. zehntneri, Ipmaulax famulus Bing. and Goniozus indicus Ashm. were observed parasitising top borer larvae, while the parasite Apanteles flavipes Cam. was recorded on the caterpillars of P. indicus.

The following predators were recorded on the sugarcane aphid, L. sacchari at Koothanallur. These were identified through the courtesy of the Forest Research Institute, Dehradun. Epistrophe sp., Calliphora sp., Verania sp., Chilocorus nigritus Fabr., Verania (Alesia) discolor Fabr., Scymnus sp., Chilomenes sp. and Brumus suturalis Fabr.

Miscellaneous

In the Rayagada area termite attack is exceptionally heavy. A trial for the control of termites was therefore laid out at the Kaniguda farm of Jeypore Sugar Co. Ltd., with 6 treatments (Table 6) in 4 randomised blocks with a plot size of 200 sq.m., using Co.419. The dusts were applied in the furrows at the time of planting in March, 1960. The attack was recorded by digging out setts from 5 per cent of the total row length in two units selected at random in each plot.

TABLE 6

Efficacy of different insecticides against termites

Treatment (at planting)	Per cent germination — weeks after planting			Average per cent termite attack (12 weeks after planting)		
	4	6	8	Buds	Ends	Setts
BHC 5 per cent dust at 22.4 kg. per hectare	50.2	53.4	36.5	37.8	49.7	50.5
BHC 5 per cent dust at 33.6 kg. per hectare	50.7	46.8	31.4	48.9	48.1	62.1
Aldrin 5 per cent dust at 22.4 kg. per hectare	50.0	50.1	39.8	11.3	15.9	9.1
Chlordane 5 per cent dust at 22.4 kg. per hectare	51.2	49.8	46.7	31.1	41.3	42.7
Heptachlor 6 per cent dust at 22.4 kg. per hectare	49.3	48.0	41.4	13.6	13.2	16.6
Control (no treatment)	26.9	26.7	18.2	67.6	81.7	83.3

After 4 weeks of planting, the average germination under all the treatments was about 50 per cent as against 26.9 per cent in the control. There was practically no further increase in germination in any of the treatments. On the other hand, it decreased progressively up to the last observation 8 weeks after planting. This decrease was due to termites attacking the germinated shoots. However the number of shoots continued to be higher in all the treated plots than under the control. At the 8-week stage, germination was the highest with chlordane 5 per cent dust.

The attack of termites was severe in the control and the least with aldrin 5 per cent dust and heptachlor 6 per cent dust.

Technical programme of work for 1961-62

1. Influence of individual weather conditions, (cloudiness, rain, humidity etc.) and general climatic conditions on the incidence and population of borers, Pyrilla and whitefly infesting sugarcane.

2. Biology of sugarcane pests.

3. Survey of cane pests.

4. Collection of insect fauna visiting sugarcane during the crop season.

Scheme for Studies of Physical and Chemical Criteria of Gur leading to the formulation of the Basis of Gur Grades- Indian Institute of Sugarcane Research, Lucknow

Annual Report for 1960-61

Objective

The objective of the Scheme is to determine the physical and chemical characteristics of gur produced in the various regions of the country so that a basis for grading gur can be formulated.

Finance and details of implementation

The financial aspects of the scheme at the Indian Institute of Sugarcane Research, Lucknow are as follows:

Period	Sanctioned grant			Actual expenditure		
	I.C.S. Rs.	Govt. Rs.	Total Rs.	I.C.S. Rs.	Govt. Rs.	Total Rs.
Since inception	1,12,000	-	1,12,000	38,704	-	38,704
For the year under report	40,000	-	40,000	25,469	-	25,469

The sanctioned grant for the scheme was Rs.40,000 and the final budget was Rs.27,500. The amount actually spent was Rs.25,469. The savings in the final estimates were mainly due to the fact that certain payments for items obtained through D.G.S. and D. were not debited to the grant within the financial year. Also there were minor savings under Allowances and Honoraria.

The Indian Central Sugarcane Committee sanctioned the Scheme for Studies on the Physical and Chemical Criteria of Gur leading to the Formulation of the Basis of Gur Grades in March, 1956. The scheme was implemented at the Indian Institute of Sugarcane Research, Lucknow from 1st April, 1959. This is the second report of the scheme.

The work of the Scheme was to be carried out as follows:

Samples of various types of gur of known characteristics were to be collected in duplicate by the State Sugarcane Research Stations at Jullundur, Shahjahanpur, Padegaon, Anakapalle, Cuddalore and Mandya. One set of samples was to be analysed for certain constituents, viz. moisture, pol, sucrose, reducing sugars, ash, insoluble impurities, pore space, etc. at the State Sugarcane Research Stations. The other set of samples was to be sent to the Indian Institute of Sugarcane Research, Lucknow for the determination of the influence of chemical constituents on keeping quality, colour, texture, hardness etc., and the evolution of standards. Bihar was to be covered by the Sugarcane Research Station, Pusa for purposes of both parts of the study.

Staff

The following staff were sanctioned in the scheme:-

Gur Chemist	(Rs.600-1150)	...	...	One
Research Assistants	(Rs.210-425)	...	...	Two
Laboratory Attendant	(Rs.75-95)	...	...	One

Shri A.S. Sastry joined the post of Gur Chemist on 25th July, 1960. He was transferred to the Gur Storage Scheme from 1st March, 1961. Shri A.K. Ghosh was Research Assistant for the whole period of the Scheme, while Shri J.P. Bajpai joined the post of Research Assistant on 8th September, 1960.

Technical programme

1. Chemical attributes responsible for different intensities of colour, texture, hardness and taste of gur.

2. Keeping quality of different types of gur and their chemical composition at different times in relation to pre-monsoon, monsoon and post-monsoon periods. Attributes responsible for poor, medium and good keeping quality of gur.

3. Nature of colloidal impurities.

4. Ash content with special reference to calcium, magnesium, chlorides, sulphates, soluble silica etc.

5. Working out rapid methods for assessing quality, colour, texture, etc.

Non-technical summary - A survey of grading procedures in the gur markets in Anakapalle, Kolhapur, Hapur, Muzaffarnagar and Meerut was conducted.

A laboratory method for the determination of hardness of gur was developed.

Determination of physical and chemical characteristics of the samples from the different States showed that Bombay samples were the hardest and lightest in colour, while those from Mysore were the darkest and softest.

Samples from Maharashtra, U.P., Mysore and Andhra Pradesh contained high amounts of reducing sugars.

Madras samples had the highest amount of calcium and chlorides. Mysore samples were low in calcium, and U.P. samples low in chlorides.

There was a fairly good negative correlation ($r = -0.44$) between hardness and moisture.

Detailed report -

After the Gur Chemist joined his post in the last week of July, 1960 a gur chemistry laboratory with necessary equipment was set up for the purpose of analytical and other

laboratory work. A preliminary survey of the important gur markets was also conducted in order to study the grading procedures followed.

1. Survey of the gur markets

The markets visited were Anakapalle (Andhra Pradesh), Kolhapur (Maharashtra) and Hapur, Muzaffarnagar and Meerut (U.P.). The important features of gur trade in these markets are briefly listed below.

Anakapalle.- This is a very important market in Andhra Pradesh. Gur is brought to the market in bucket-shaped blocks, each weighing about 13 kg. This market dealt with about 67,000 metric tons of gur in 1960. The grades used in this market and their characteristics and prices are given below.

TABLE 1

Grade characteristics of gur in Anakapalle market

Grade designation	Grade characteristics	Price per quintal
Special	Light gold colour, hard, crystalline.	Rs.40.00
No. 1	Golden, less hard, crystalline.	Rs.37.50
No. 1.1/2	Light brown, less hard, no crystals.	Rs.37.00
No. 2	Dark brown, less hard, no crystals.	Rs.35.00
No. 3	Black, less hard, no crystals.	Rs.30.00

Kolhapur.- This market is the most important in Maharashtra. Here also gur is stocked and sold in the form of buckets, each weighing about 30 kg. The Central Warehousing Corporation classifies gur in three grades; their characteristics and prices are given below:

TABLE 2

Grade characteristics of gur in Kolhapur market

Grade designation	Grade characteristics	Price per quintal
1.	Yellow, very hard, very sweet, without objectionable odour.	Rs.54 to 59
2.	Golden yellow or dark brown, very hard and very sweet.	Rs.46 to 51
3.	Dark brown, green or blackish brown, hard, slightly saltish.	Rs.40.00

Hapur.- This is a medium-size market in U.P. About 60 per cent of the gur is marketed in bucket-shaped blocks and another 30 per cent as Pansera (large bun-shaped lumps weighing 5 seers i.e. about 4.7 kg. each). A small quantity is marketed as Dhaiah (bun-shaped lumps weighing of 2.1/2 seers i.e. about 2.3 kg. each). These categories are graded into four grades mostly based on the colour of the gur. The grades, their characteristics and prices are given below.

TABLE 3

Grade characteristics of gur in Hapur market

Grade designation	Grade characteristics	Price per quintal
No.1	Golden yellow, hard, crystalline	Rs.36.00
No.1.1/2	Yellow with reddish and greenish tinge, hard, crystalline.	Rs.35.00
No.2	Greenish, tending to dark, soft, less crystalline.	Rs.33.50
No.3	Dark, soft, no crystals.	Rs.24 to 30

Muzaffarnagar.- This is one of the most important markets in U.P. About 50 per cent of the gur handled in this market is Chaku Minjha. The other types are Laddoo (5 per cent), Raskat Khurpapar (25 per cent), Gur Masala, Shakkar and Pansera (20 per cent). Chaku Minjha is graded into 3 grades, mostly based on the colour of the layers. The characteristics of these grades and prices are given below.

TABLE 4

Grade characteristics of gur in Muzaffarnagar market

Grade designation	Grade characteristics	Price per quintal
No.1	Thin layers of whitish colour, hard, crystalline.	Rs.40.00
No.2	Broader layers, slightly reddish, less hard, less crystalline.	Rs.39.00
No.3	Broader layers, dark, soft, no crystals.	Rs.37.50

Meerut.- This is another important market in U.P. About 70 per cent of the gur marketed is in the form of Pansera. The grade characteristics and prices of this type are given below.

TABLE 5

Grade characteristics of gur in Meerut market

Grade designation	Grade characteristics	Price per quintal
No.1	Yellow, hard, sweet.	Rs.36.00
No.1½	Yellow with saffron tinge, hard, sweet.	Rs.35.50
No.2	Yellow with reddish tinge, less hard, less sweet.	Rs.35.00
No.3	Reddish brown with greenish tinge, soft, bitter.	Rs.33.50
No.4	Greenish tending to dark, soft, salty.	Rs.32.00

From the above, it is clear that gur is graded in general in markets on the basis of colour, hardness, texture and taste. In U.P. markets much importance appears to be attached to the colour of gur. In Anakapalle and Kolhapur, hardness is also greatly valued. Prices are highest in the Kolhapur market.

2. Analytical work

For the laboratory determinations of the various physical characteristics and chemical constituents of the gur samples received from various parts of the country, the following methods were used/developed.

Colour.- Colour was measured on a half-normal solution of gur in a Klett Summerson photoelectric colorimeter using 540 mu filter. The instrument was set to zero with distilled water.

Hardness.- A method for measuring the hardness of gur was developed. The gur block was placed on a hard surface and a brass nail was stood vertically over it with the pointed end on the gur block. A graduated glass tube of just the required diameter to hold the nail in place and position and at the same time ensure free vertical movement for the nail was then slipped over the nail. A cylindrical weight of 60 g. was dropped through the tube on the head of the nail through a height of 50 cm. The depth in millimeters through which the nail penetrated the gur block was measured. On each gur block three readings were taken, one on either side of the block and one in the middle region after cutting the block into two. Three blocks were used for each sample. The reciprocal of the average of the nine readings was taken as the hardness of gur.

Texture.- A method for the determination of texture of gur has been developed at the Sugarcane Research Station, Pusa. This was slightly modified, tested and found to give fairly duplicable values. The method consists of rubbing 5 g. of gur with 3 cc. of glycerine with a policeman to disperse

the crystals, and then treating it with acidified sugar-saturated rectified spirit (90 parts rectified spirit mixed with 10 parts of acetic acid and saturated with sugar). The crystals are allowed to settle and the supernatant liquid decanted through a tared sintered crucible. The crystals are then transferred to the crucible, washed with 5 cc. lots of the spirit, dried and weighed.

Keeping quality of gur.- In order to determine the attributes responsible for poor, medium and good keeping quality of gur, a rapid method is being developed. Also periodical analysis of the gur samples through the monsoon is being carried out by the collaborating State Sugarcane Research Stations and these data are being obtained and examined to find out the pre-monsoon, monsoon and post-monsoon composition of gur.

Ash constituents.- The ash constituents, calcium and chlorides in the gur samples were determined by titration with EDTA and silver nitrate. Magnesium and sulphates could not be determined during the year under report because of difficulty in getting the required chemicals in time.

3. Rapid methods for assessing colour, hardness and texture of gur

Efforts are being made to develop rapid methods for assessing colour, hardness and texture of gur.

4. Study of variation in the physical and chemical attributes of gur samples

In the study for the formulation of the basis of gur grades, representative samples of gur collected during 1959-60 were received from Andhra Pradesh, Madras, Mysore, Maharashtra, U.P. and the Punjab.

They were analysed for colour, hardness, moisture, reducing sugars, calcium and chlorides. In all 146 samples have been analysed. The range of variation in these constituents is presented in table 6.

TABLE 6

Chemical composition of gur samples from the different States

		Uttar Pradesh	Andhra Pradesh	Mysore	Madras	Maharashtra	Punjab
1		2	3	4	5	6	7
Colour transmission	Min.	206	102	201	135	195	269
	Max.	775	900	900	900	590	900
	Av.	446	470	604	494	304	564
Hardness (Reciprocal of mm. penetrated by nail)	Min.	0.66	2.00	0.05	0.66	2.73	0.50
	Max.	3.57	5.00	2.50	5.55	4.88	4.16
	Av.	1.60	3.04	1.46	2.90	3.96	2.04

1		2	3	4	5	6	7
Moisture per cent	Min.	4.49	2.65	3.68	3.76	2.04	3.89
	Max.	8.63	12.10	10.73	7.65	6.34	8.09
	Av.	6.60	6.87	6.34	5.70	4.72	5.81
Reducing sugar per cent	Min.	7.30	6.10	5.84	3.85	8.11	3.85
	Max.	20.63	22.18	18.08	15.10	18.94	13.80
	Av.	12.06	11.76	11.95	7.15	12.83	8.51
Calcium per cent	Min.	0.19	0.20	0.16	0.18	0.22	0.16
	Max.	0.57	0.59	0.61	0.75	0.43	0.45
	Av.	0.30	0.31	0.27	0.40	0.32	0.28
Chloride per cent	Min.	0.17	0.18	0.17	0.10	0.19	0.08
	Max.	0.79	0.97	1.37	1.13	0.65	1.00
	Av.	0.37	0.45	0.46	0.64	0.41	0.47

It is seen that Maharashtra samples were the lightest in colour, while Mysore samples were the darkest. The samples from other States were intermediate in colour.

The samples from Maharashtra were the hardest, while those from Mysore and U.P. were the softest. Samples from Andhra Pradesh, Madras and the Punjab were of intermediate hardness.

The moisture content of the samples ranged from 2.0 to 12.1 per cent. The majority of the samples contained 5 to 9 per cent moisture.

Reducing sugars ranged from 3.9 to 22.2 per cent. The samples from Maharashtra, U.P., Mysore and Andhra Pradesh contained fairly high amounts of reducing sugars, while those from Madras and the Punjab contained low amounts.

Calcium content of the samples ranged from 0.16 to 0.75 per cent. Madras samples had the highest amount while Mysore samples had the lowest.

The chloride content of the samples varied from 0.08 to 1.37 per cent. Madras samples had the highest amount while U.P. samples had the lowest.

5. Study of chemical attributes responsible for different intensities of colour, texture and hardness of gur

Correlations between the physical characteristics of the samples and the chemical constituents in them were worked out. It was found that therewas a significant negative correlation between hardness and moisture ($r = -0.44$). The correlation between colour and calcium was $r = +0.33$ and that between colour and chlorides was $r = +0.26$. These values were significant. The correlations between hardness and calcium, and hardness and chlorides were equally low.

The correlations between colour and reducing sugars, and between hardness and reducing sugars were negligibly small.

Technical programme of work for 1961-62

1. The chemical attributes responsible for different intensities of colour, texture, hardness and taste of gur.

2. Keeping quality of different types of gur and their chemical composition at different times in relation to pre-monsoon, monsoon and post-monsoon periods. Attributes responsible for poor, medium and good keeping quality of gur.

3. Ash content with special reference to calcium, magnesium, chlorides, sulphates and sulphites.

4. Working out rapid methods for assessing quality, colour, texture etc.

GS

Scheme for Studies in Storage of Gur

Indian Institute of Sugarcane Research, Lucknow

Annual Report for 1960-61

Objective

The objective of the Scheme is to elucidate by systematic studies the effect of various environmental and other factors on the keeping quality of gur with the ultimate objective of evolving suitable methods of storage.

Finance and details of implementation

The financial aspects of the scheme are as follows:

Period	Sanctioned grant			Actual expenditure		
	ICSC Rs.	Govt. Rs.	Total Rs.	ICSC Rs.	Govt. Rs.	Total Rs.
Since inception	1,50,000	nil	1,50,000	23,905	nil	23,905
For the year under report	75,000	nil	75,000	19,734	nil	19,734

The sanctioned grant for the Scheme for the year was Rs.75,000 and the final budget was Rs.25,000. The amount actually spent was Rs.19,734. The savings in the final estimates were mainly due to payments of the supplies obtained through D.G.S. and D. not being debited to the grant during the year.

The Indian Central Sugarcane Committee sanctioned the Scheme for Studies in Storage of Gur in April 1958. The Scheme was implemented in May, 1959. This is the second report of the Scheme.

Staff - The following staff were sanctioned in the Scheme.

Research Assistants (Rs.210-425) ... ... Two
Laboratory Attendant(Rs.75-95) ... ... One

The Scheme was to operate under the technical and administrative control of the Gur Chemist of the Gur Grading Scheme. Shri A.S.Sastry joined the post of Gur Chemist on 25th July 1960 and was in charge of this scheme also. He was transferred to the Gur Storage Scheme with effect from 1st March 1961.

The research assistants Shri M.P. Agarwal and Shri S.S. Chatterji joined their posts on 23rd September and 3rd October 1960 respectively.

Technical programme of work 1960-61

1. Elucidation of the exact physical conditions causing deterioration of gur in storage.

   i) Influence of different temperatures and humidities on the keeping quality of gur.

   ii) Comparative tests on storage of gur and assessment of conditions in trade godowns.

   iii) Effect of cold storage on the quality of gur.

2. The relationship between the chemical constituents of gur and nature of spoilage taking place in stored gur.

   i) Influence of varieties and stages of maturity on the keeping quality of gur.

   ii) Influence of chemical constituents on the keeping quality of gur.

      a) Ash constituents
      b) Sugar constituents
      c) Hydros.

Non-technical summary - The post of Gur Chemist was filled in late July 1960; the assistants were recruited in September and October. Research work on certain aspects was taken up immediately, but the laboratory itself was fitted out and the necessary chemicals and glassware were procured only by about December 1960. During the short available period, 6 experiments under the technical programme were conducted.

Experiments on the keeping quality of gur at different temperatures and humidities showed that at 43 per cent relative humidity (RH), gur with a starting moisture content of about 6 per cent tended to lose its moisture. At relative humidities of 71 per cent and above, this gur gained in moisture, the gain being strikingly more at room temperature than at low temperature. There was negligible darkening in colour of gur at low temperature at all the humidities tried, but at room temperature it was considerable at humidities above 71 per cent. Within the period of 30 days, changes in sucrose and invert sugars were of a negligible order.

In a more precise second experiment, gur kept at 51 per cent RH at room temperature lost about 2 per cent in weight in 21 days. There was no darkening in the colour of gur. At 58 per cent RH there was a slight gain in weight and moisture content and darkening in colour. As the humidity increased above 58 per cent, the gain in moisture content progressively increased. There was darkening in colour also. There was no great change in sucrose and invert sugars at any of the humidities. These results suggest that the optimum humidity for preservation of gur lies between 51 and 58 per cent.

In comparative tests and assessment of trade godowns, specially prepared gur of different known quali-

ties was stored in the godowns at Rajahmundry, Kolhapur, Dankaur and Muzaffarnagar. Samples of these gur lots are being periodically analysed.

To study the effect of cold storage, gur of different qualities was stored in polyethylene-lined gunnies in cold storage. Samples are being periodically analysed.

In order to study the influence of varieties and maturity on keeping quality, gur was prepared from the varieties Co.997, and Co.951 at three different stages of maturity and was stored under Lucknow conditions. Samples are being periodically analysed.

Gur of various compositions was manufactured for the purpose of conducting controlled studies on the effects of excess and deficiency of constituents on the storage quality of gur.

Detailed report -

The post of Gur Chemist was filled in late July 1960 and the research assistants were recruited in September and October 1960. The Gur Chemistry laboratory was set up with necessary equipment by December 1960. Preparatory work was started and detailed programme of experiments was drawn up.

During the year the following investigations have been carried out.

1 & 2. Influence of different temperatures and humidities on the keeping quality of gur

For this purpose two experiments were conducted. In the first experiment, gur purchased from the farm of the Indian Institute of Sugarcane Research, Lucknow was cut into 3.8 cm. cubes, and these were kept in duplicate in desiccators. The atmosphere inside the desiccators was artificially maintained at different relative humidities. One set of desiccators was maintained at room temperature (mean 31.2 ± 2.8°C), the other at low temperature (1.5° ± 1.5°C). The relative humidities employed were 43, 71, 81, 90 and 100 per cent. The gur cubes were analysed in duplicate, initially and at the end of 15 and 30 days for moisture, colour, pol, sucrose and reducing sugars.

TABLE 1

Effect of temperature and humidity on moisture content of gur

Relative humidity per cent	Moisture per cent gur					
	Low temperature (1.5°C)			Room temperature (31.2°C)		
	Initial	After 15 days	After 30 days	Initial	After 15 days	After 30 days
43	6.20	7.01	4.24	6.03	4.23	5.37
71	6.20	5.32	8.14	6.03	6.78	7.89
81	6.20	6.48	11.34	6.03	13.07	14.99
90	6.20	8.26	13.39	6.03	15.24	30.38
100	6.20	8.85	15.88	6.03	25.50	35.27

TABLE 2

Effect of temperature and humidity on the colour of gur

Relative humidity per cent	Colour* (oven dry basis)					
	Low temperature (1.5°C)			Room temperature (31.2°C)		
	Initial	After 15 days	After 30 days	Initial	After 15 days	After 30 days
43	54.0	53.0	54.5	53.0	55.5	53.5
71	54.0	53.5	52.0	53.0	54.5	50.5
81	54.0	53.0	50.5	53.0	51.0	43.0
90	54.0	53.0	50.5	53.0	51.0	45.0
100	54.0	54.0	50.0	53.0	48.0	39.5

* Colour was determined on N/2 gur solution by Bausch and Lomb Colorimeter using 505 mu filter. The instrument was adjusted to 100 with distilled water. Hence, decrease in reading shows increase in colour.

Low temperature		Room temperature	
Maximum	3°C	Maximum	34.0°C
Minimum	0°C	Minimum	28.4°C
Average	1.5°C	Average	31.2°C

TABLE 3

Effect of temperature and humidity on the pol of gur

Relative humidity per cent	Pol per cent gur (oven dry basis)					
	Low temperature (1.5°C)			Room temperature (31.2°C)		
	Initial	After 15 days	After 30 days	Initial	After 15 days	After 30 days
43	82.90	84.45	84.50	83.90	83.25	82.55
71	82.90	79.65	80.50	83.90	82.15	79.70
81	82.90	81.20	81.60	83.90	81.55	84.30
90	82.90	81.10	82.80	83.90	*	81.35
100	82.90	83.70	85.60	83.90	81.25	80.50

* Could not be determined as the sample was lost.

TABLE 4

Effect of temperature and humidity on sucrose of gur

Relative humidity per cent	Sucrose per cent gur (oven dry basis)					
	Low temperature (1.5°C)			Room temperature (31.2°C)		
	Initial	After 15 days	After 30 days	Initial	After 15 days	After 30 days
43	87.50	87.05	86.70	84.40	82.20	84.50
71	87.50	82.25	89.30	84.40	83.20	82.70
81	87.50	84.80	85.90	84.40	84.15	87.70
90	87.50	85.50	85.65	84.40	*	84.40
100	87.50	87.05	87.30	84.40	83.90	83.15

* Could not be determined as the sample was lost.

TABLE 5

Effect of temperature and humidity on reducing sugar of gur

Relative humidity per cent	Reducing sugar per cent gur (oven dry basis)					
	Low temperature (1.5°C)			Room temperature (31.2°C)		
	Initial	After 15 days	After 30 days	Initial	After 15 days	After 30 days
43	11.79	12.15	11.95	12.52	13.14	13.00
71	11.79	11.89	12.75	12.52	13.44	11.87
81	11.79	11.50	11.84	12.52	14.72	11.34
90	11.79	11.93	12.81	12.52	14.86	14.36
100	11.79	10.04	12.06	12.52	17.48	15.59

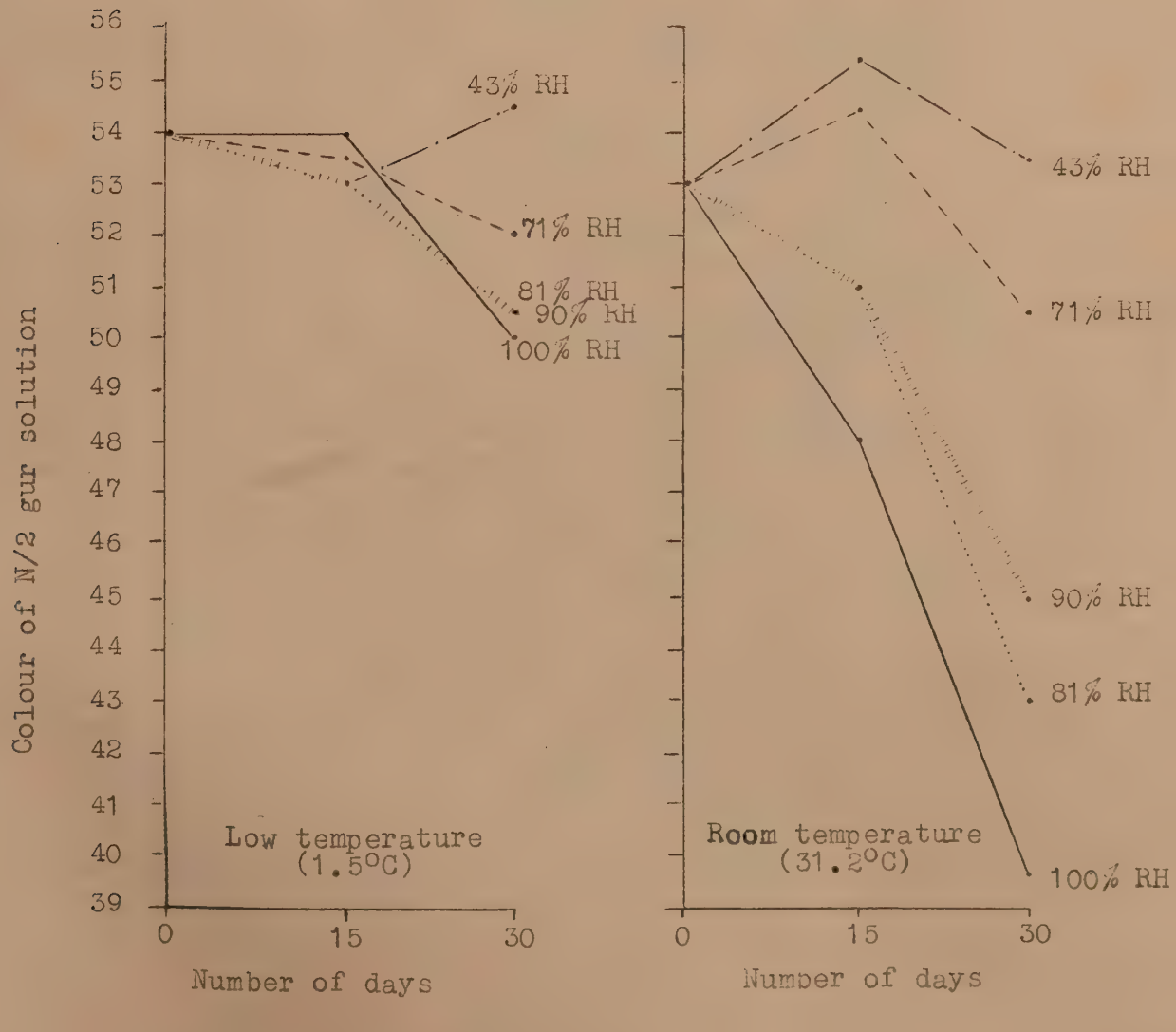
From the data (Tables 1 to 5) it appears that

i) At 43 per cent RH, the gur tended to lose its moisture.

ii) Above 71 per cent RH, gur gained in moisture, the gain being much more at room temperature than under low temperature.

iii) The deterioration in the colour of gur at 1.5°C was negligible at all the humidities, while at room temperature it was considerable at humidities above 71 per cent (Fig.1).

Fig.1 Effect of temperature and humidity on the colour of gur



iv) The changes in pol, sucrose and reducing sugars were negligible at low temperature at all humidities, while at room temperature, reducing sugars showed a tendency to increase at 90 and 100 per cent RH.

From these results it appears that the optimum relative humidity for preservation of gur, both at low temperature and room temperature lies between 43 and 71 per cent.

However as this range of humidity was too wide and as it was desirable to get more precise information, a second experiment was conducted. Also in order to reduce variations due to heterogeneity of the raw material, gur was specially prepared and cast into cubical moulds of 3.8 cm. size. The variety of cane used was Co.997 and gur was prepared on two dates, 16th January and 1st April 1961.

The cubes were kept in desiccators maintained at 51, 58, 66, 71, 81 and 90 per cent relative humidity at room temperature. The maximum and minimum temperature of the room where the desiccators were kept was recorded every day, and varied from 32.6°C to 40.6°C. The average temperature for the whole period of the experiment was 36.5°C. The temperature range during the 3 weeks of the experiment was about the same.

The cubes in the desiccators were analysed initially and at the end of 7, 14, and 21 days for increase in weight, moisture, colour, pH, pol, sucrose and reducing sugars. In order to get a measure of the precision of these determinations, 4 cubes of each variety of gur were individually analysed for the above constituents. The weight changes and moisture per cent gur are presented in table 6.

TABLE 6

Effect of humidity on the moisture content of gur

Relative humidity per cent	Gain (+) or loss (-) in weight of gur per cent initial weight			Moisture per cent gur			
	At the end of				At the end of		
	7 days	14 days	21 days	Initial	7 days	14 days	21 days
1	2	3	4	5	6	7	8
Gur prepared from Co.997 on 16th January 1961							
51	+ 1.14	- 0.81	- 2.10	2.14	1.95	2.52	2.19
58	+ 0.76	+ 0.21	- 0.12	2.14	2.54	3.20	2.72
66	+ 1.50	+ 1.29	+ 0.88	2.14	3.69	4.21	3.07
71	+ 1.45	+ 1.48	+ 2.49	2.14	3.83	4.50	4.25
81	+ 3.29	+ 5.44	+ 7.13	2.14	4.13	6.29	6.67
90	+ 5.68	+ 8.66	+11.47	2.14	7.06	9.05	12.82
Gur prepared from Co.997 on 1st April 1961							
51	+ 0.79	- 1.58	- 1.80	2.04	1.76	1.95	1.41
58	+ 0.45	+ 0.22	+ 0.22	2.04	2.49	3.62	3.47
66	+ 0.65	+ 1.65	+ 1.33	2.04	2.77	4.17	3.60

1	2	3	4	5	6	7	8
71	+ 1.40	+ 1.96	+ 1.91	2.04	2.58	4.32	4.14
81	+ 3.93	+ 5.03	+ 5.55	2.04	4.47	7.64	7.86
90	+ 5.82	+ 9.10	+12.41	2.04	5.71	9.89	12.63

X S.E. of initial moisture per cent = ± 0.12
* S.E. of initial moisture per cent = ± 0.097

The results showed that -

i) Gur with an initial moisture of about 2 per cent, when kept at 51 per cent relative humidity and room temperature lost about 2 per cent of weight in 21 days.

ii) There was a slight gain in weight and moisture at 58 per cent relative humidity.

iii) As the humidity increased above 58 per cent, the gain in the weight and moisture of gur progressively increased.

The changes which took place in colour of gur are recorded in table 7.

TABLE 7

Effect of humidity on the colour of gur

Relative humidity per cent	Colour * (oven dry basis)							
	At the end of				At the end of			
	Initial	7 days	14 days	21 days	Initial	7 days	14 days	21 days
	Gur prepared from Co.997							
	On 16th January, 1961				On 1st April, 1961			
51	433 X	423	427	417	497*	466	482	487
58	433	429	429	493	497	507	555	544
66	433	444	483	498	497	499	556	555
71	433	437	479	493	497	452	562	584
81	433	436	485	481	497	472	583	578
90	433	432	470	479	497	461	546	578

* Colour was determined on N/2 solution in a Klett Summerson Photoelectric Colorimeter using 540 mu filter and adjusting to 0 with distilled water. Hence increase in reading shows increase in colour.

X S.E. for colour of initial sample = ± 12.1

* S.E. for colour of initial sample = ± 14.3

i) At 51 per cent relative humidity, there was no darkening of the colour of the gur in 21 days.

ii) At 58 per cent relative humidity and above the gur tended to darken in colour.

Data on sugar constituents are presented in tables 8 to 10.

TABLE 8

Effect of humidity on the pol of gur

Relative humidity per cent	Pol per cent (oven dry basis)							
	Initial	At the end of 7 days	14 days	21 days	Initial	At the end of 7 days	14 days	21 days
	Gur prepared from Co.997							
	On 16th January, 1961				On 1st April, 1961			
51	81.84[X]	83.53	84.34	85.79	84.62*	83.36	83.12	85.39
58	81.84	82.89	82.48	84.32	84.62	83.48	84.71	85.88
66	81.84	82.97	82.46	82.67	84.62	83.34	85.53	85.06
71	81.84	82.96	82.00	82.40	84.62	82.12	84.56	84.86
81	81.84	82.51	82.81	81.34	84.62	82.70	83.64	85.61
90	81.84	83.35	81.26	83.51	84.62	83.15	82.54	85.29

X S.E. of initial pol per cent = ± 0.12

* S.E. of initial pol per cent = ± 0.40

TABLE 9

Effect of humidity on sucrose content of gur

Relative humidity per cent	Sucrose per cent (oven dry basis)							
	Initial	At the end of 7 days	14 days	21 days	Initial	At the end of 7 days	14 days	21 days
	Gur prepared from Co.997							
	On 16th January 1961				On 1st April 1961			
51	83.78[X]	84.36	85.83	84.63	84.43*	83.62	83.19	84.80
58	83.78	83.12	84.47	84.07	84.43	83.63	85.93	85.90
66	83.78	83.20	83.87	82.34	84.43	83.54	86.45	85.96
71	83.78	82.84	83.90	82.37	84.43	81.78	85.22	84.73
81	83.78	82.94	84.07	82.05	84.43	83.13	84.52	84.44
90	83.78	83.94	84.07	84.57	84.43	83.80	82.42	85.89

X S.E. of initial sucrose per cent = ± 0.27

* S.E. of initial sucrose per cent = ± 0.29

TABLE 10

Effect of humidity on reducing sugars of gur

Relative humidity per cent	Reducing sugars per cent (oven dry basis)							
	Initial	At the end of			Initial	At the end of		
		7 days	14 days	21 days		7 days	14 days	21 days
	Gur prepared from Co.997							
	On 16th January, 1961				On 1st April, 1961			
51	6.84[X]	7.40	7.22	7.14	6.99*	6.48	6.73	7.03
58	6.84	7.32	7.32	6.85	6.99	6.49	6.82	6.73
66	6.84	7.58	7.07	6.69	6.99	6.36	6.13	6.44
71	6.84	7.44	7.16	7.07	6.99	6.82	6.42	6.25
81	6.84	7.07	7.23	7.41	6.99	6.71	6.38	6.76
90	6.84	6.54	7.06	8.13	6.99	6.51	6.17	7.16

X S.E. of initial reducing sugars per cent = ± 0.08

* S.E. of initial reducing sugars per cent = ± 0.05

The changes in these constituents in the course of 21 days were negligible at all the humidities.

The changes in the pH of gur were also negligible under all the humidities.

The results suggest that the optimum humidity for preservation of gur lies between 51 and 58 per cent.

3. Comparative tests on storage of gur and assessment of conditions in trade godowns

In order to make a comparative study of storage conditions and effects of these on the stored gur in different trade godowns, special arrangements were made with commercial godown-owners in the principal gur markets of India for carrying out the experiments and for collection of data. Gur of different and known qualities was specially prepared, divided into samples and stored under trade conditions in godowns of Rajahmundry, Kolhapur*, Dankaur and Muzaffarnagar. Arrangements have been made for recording temperature and humidity changes inside the godown during the period of storage with use of thermo-hygrographs installed in the godowns. Samples are being drawn from the gur at monthly intervals, and analysed for moisture, pol, sucrose, reducing sugars, colour and pH. Loss or gain in weight is also being recorded periodically. The studies were started in May, 1961 and are in progress; they will be completed with the termination of the storage period in the monsoon months of 1961.

* Thanks are due to the staff of the Central Warehouse, Kolhapur for their help and cooperation in the conduct of the experiments.

4. Effect of cold storage on the quality of gur

In order to study the influence of low temperature on the keeping quality of gur, gur of different qualities was prepared from varieties Co.997 and Co.951 and has been stored in polyethylene-lined gunnies in commercial storage. Records of daily temperature and humidity are being kept and the samples are being drawn at monthly intervals and analysed for moisture, pol, sucrose, reducing sugars, colour and pH. These studies are in progress and will be completed with the end of the monsoon period of 1961.

5. Influence of varieties and stages of maturity on the keeping quality of gur

In order to study the influence of varieties and maturity of cane on the keeping quality of gur, gur was prepared from the varieties Co.997 and Co.951 at three different stages of maturity and stored in a godown under Lucknow conditions. The temperature and humidity in this godown are daily recorded by a thermohygrograph. Suitable sub-samples are being drawn at monthly intervals and analysed for moisture, pol, sucrose, reducing sugars, colour and pH. The studies are in progress.

6. Influence of chemical constituents on the keeping quality of gur

To study the influence of chemical constituents on the keeping quality of gur, gur of various compositions having an excess or deficiency of particular constituents was manufactured under controlled conditions. The chemical compounds used were calcium chloride, magnesium sulphate, sucrose, glucose, and Hydros. The changes in the composition and the keeping quality of these gur samples is being studied in order to find out the precise influence of the constituents.

Technical programme of work 1961-62

1. Elucidation of the exact physical conditions causing deterioration of gur while in storage.

i) Influence of different temperatures and humidities on the keeping quality of gur.

ii) Comparative tests on storage of gur and assessment of conditions in trade godowns.

iii) Effect of cold storage on the quality of gur.

iv) Effect of pressure on the quality of gur.

2. The relationship between the chemical constituents of gur and nature of spoilage taking place in stored gur.

i) Influence of varieties and stages of maturity on the keeping quality of gur.

ii) Influence of clarificants on the keeping quality of gur.

iii) Influence of chemical constituents on the keeping quality of gur: a) Ash constituents, b) Sugar constituents, c) Hydros, d) Nitrogenous substances and e) Moisture.

3. Designing and testing of a suitable godown.

1) for storage of gur for trade purposes.
2) for storage in villages and small growers' cooperatives.